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An Economical Bridge-Pier Foundation

By Milo K. Temple*

The new line of the Southern Pacific from Eugene to Marshfield, in Oregon, a distance of about 122 miles, bridges Coos Bay at a point where the latter is about a mile wide. The steelwork for this bridge will consist of nine 150-ft. spans, two 180-ft. spans, and one 458-ft. drawspan, a total of 2208 ft. of steel. A five-pile-bent ballast-deck trestle, of cedar piles and cedar lumber (with the exception of the stringers, which are of fir), will make up the remaining section of 2988 ft. There will be in all 14 piers, containing about 16,000 yd. concrete. It being an all-sand foundation, the piers in turn will rest on close driven piles reaching from 30 to 45 ft. below bottom of concrete. (See Fig. 2.) Construction work was started in July, 1914. The center or pivot pier was completed Feb. 1, 1915. It is the largest of the piers and will support the drawspan, which weighs about 1000 tons. This is a center-bearing swingspan and will allow of 200 ft. in the clear on each side of the center pier.

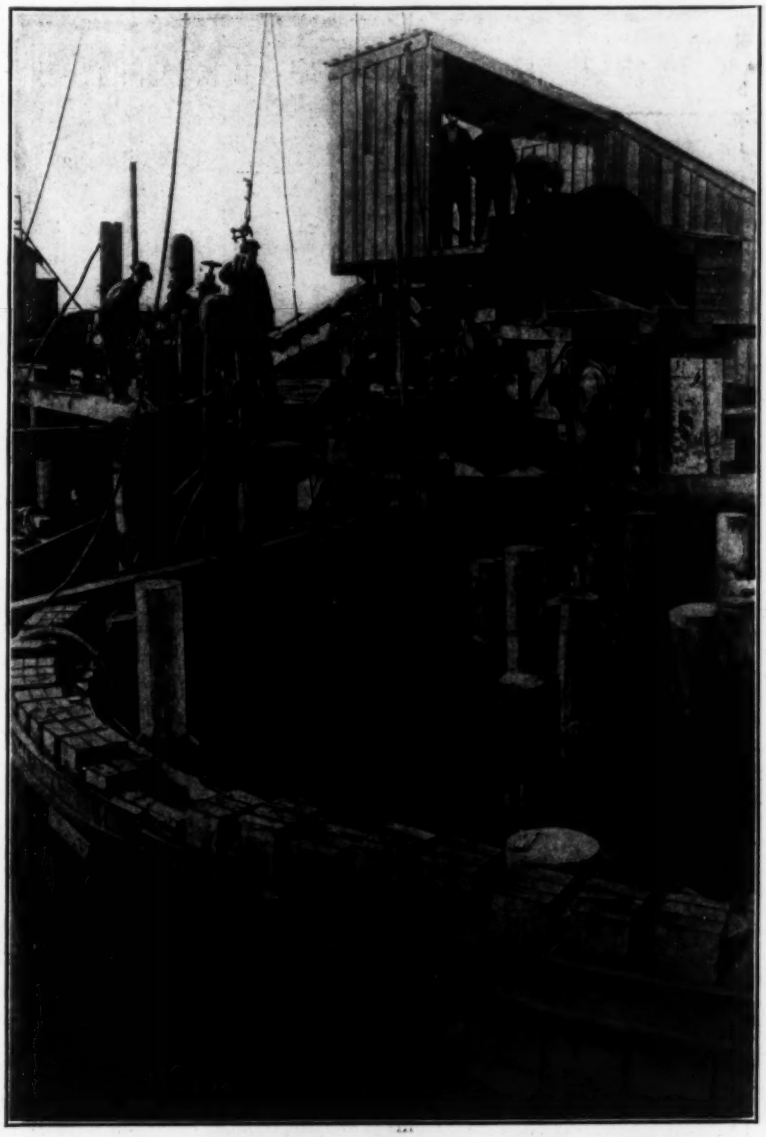

Fig. 1. Sheetpile Casing for Pivot Pier of Coos Bay Bridge

(Sandpump in operation. Men are handling jetpipe to stir up material for suction of pump. At right, under mixer spout, is the bucket used to lower concrete through water.)

The pivot pier is cylindrical in shape; it measures 38 ft. in diameter in the distance from bottom of concrete to low-water line and 31 ft. in diameter above low-water. It has a total depth of 53.7 ft., contains approximately 1800 yd. of concrete and rests on 141 foundation piles. The concrete for this pier was placed through the water inside a wooden sheetpile casing, a method which proved both economical and productive of satisfactory results.* It eliminates the use of a caisson or expensive cofferdam, no special effort being made to have the sheetpile casing watertight. The depth of water at this pier at ordinary high tide is about 23 ft. at the present time. Proposed changes in the depth of the channel, however, to be made by the government will deepen this some 15 ft., and of course all plans had to be made accordingly. As constructed, the bottom of concrete is 48 ft. below ordinary high water, 25 ft. below present ground surface and 10 ft. below proposed bottom of channel. The method of construction was as follows: After the driving of some piles for a working false-work, eight piles were driven in a 32-ft. circle preparatory to lowering around them a steel frame 25 ft. high to serve as a guide for the sheetpiles in driving. This

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*The same method will be used for the other piers.

frame consisted essentially of 10-in. 25-lb. I-beams for guiding arcs, 8-in. 18-lb. I-beams for columns, 3½x3½x½-in. angles for cross-bracing, and 8-in. 11¼-lb. channels for retaining arcs. It was lowered till it rested on the bed of the channel, being kept supported while the scouring and filling of the sand gave it an even bearing.

Then 118 wooden sheetpiles 60 ft. long were driven around the guiding frame to form the casing for the concrete. These piles were built up of three pieces of 4x12 lumber to form a 12x12 tongue-and-grooved stick; the 4-in. tongue was adzed on one side to fit into the groove properly, as the piles in following the circumferential arc engage one another at an angle of about 3°. The points of the piles were sloped in the usual way to insure close contact. To obtain proper staggering of the timber joints in each pile, the inside run of 4x12-in. was made up of two pieces 30 ft. long and each of the outside runs of one piece 40 ft. and one piece 20 ft. long. Eighteen ⅝x10½-in. machine bolts (both ends sunk into the timber) and twelve ½x9-in. boat spikes were used to each pile.

The sheetpiling was driven with a 3300-lb. drop hammer aided by a 2½-in. jet. The jetpipe was rigged up on the driver and handled by one of the donkey engine's gypsies. Wire-wound hose (2½-in.) was used to connect the jetpipe with an 8x5x10-in. Dow pump. This pump and the locomotive boiler supplying it with steam were located on a barge alongside. This worked very satisfactorily, there being no limit to the efficiency of the jet through the hard-packed sand. At times during the driving the piles had to be snubbed to keep them from following the hammer up into the leads. To drive the piles as solidly as possible, however, only the minimum amount of jetting consistent with reasonable progress was resorted to. But it was demonstrated that it took only a very short time for the sand most thoroughly to repack itself around the pile, and probably giving the pile as much bearing as though directly driven. The casing held perfectly, there being no movement during the heaviest tidal currents.

Excavation was then begun, the aim being to excavate the casing to 3 or 4 ft. below proposed bottom of concrete, thus allowing for any uplift while driving the foundation piles. A 1½-yd. clamshell bucket was used. After removal of the comparatively soft top strata, the sand and shells were found to be packed so hard that in order to obtain any progress the jet had to be used to loosen this material; and this had to be continued until the excavation was completed. While the dredging was progressing, soundings were regularly taken to ascertain whether any of the outside material was being forced through the casing. No leakage could be noted.

When the excavation reached El. —18 (bottom of concrete being El. —15) there was a slight uplift. This presumably was caused by the weight of the superimposed material outside the casing, the excavation having then a depth of 28 ft. below natural ground surface. Excavating was discontinued and no further uplift took place. This left about 8 ft. of sheetpiling below bottom of excavation.

The next step was the driving of the 141 foundation piles. This was accomplished with the jet. Proper care was taken not to disturb the sheetpiles during this operation; for instance, while driving the outer rows nearest the casing, the jetpipe was kept on the side of the pile away from the casing. No difficulty was experienced.

It will be noticed that these piles extend up into the concrete almost to low-water line. This is to provide a reinforcement against lateral pressures.

As was to be expected, the jetting of the foundation piles caused a rise in the bottom of the excavation. This amounted to about a 5-ft. uplift. To excavate the 3 ft. necessary to reach bottom of concrete a 5-in. Hendy "Water Lifter" was used, the makeup and shape of this sandpump being such as to allow of its being dragged about between the closely driven piles. The bottom of concrete being at El. —15 and the top of the sheetpiling at El. +33, the sand required to be excavated had to be lifted a maximum of about 50 ft. To raise sand and

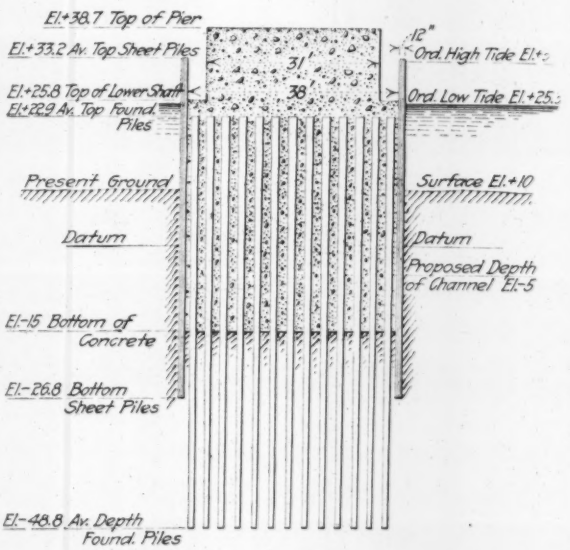


FIG. 2. VERTICAL SECTION OF PIVOT PIER

water that height the lifter needs a head of about 325 ft. This was supplied by a compound Fairbanks-Morse pump 8&12x7x12-in., which was rigged up on the falsework, as shown in accompanying photograph. Jetting had again to be resorted to, the suction at the bottom of the lifter not having sufficient effect on the closely packed sand without a previous stirring up of the material. The lifter moved an average of from 5 to 10 yd. per hour.

Concrete (1:2:4 sand-and-gravel mix) was deposited through the water by means of a cylindrical bottom-dump bucket, 26 in. in diameter by 64 in. high, of a capacity of something over half a yard, and was handled with a stiffleg derrick. The foundation piles act as guides in the lowering of the bucket.

When the concrete reached El. +23, enough water was pumped out of the casing to allow the foundation piles to be cut off a little below low-water elevation. No particular pains are taken to have the casing water-tight, but it becomes so sufficiently for this purpose. Two 6-in. centrifugal pumps and an Emerson pump kept the level of the water about a foot lower than the tide. The 38-ft.-diameter shaft was then stepped in and forms built for the 31-ft. upper shaft. A 1:2:6 concrete was placed into the latter, above water, in the usual way. Short vertical pieces of old rail were used to help form a better bond between the upper and lower shafts of concrete.

The Coos Bay bridge is being constructed under the direction of William Hood, Chief Engineer, Southern Pacific Co. The field work is in charge of C. R. Broughton, Assistant Engineer.

The Turbines of the Cedars Hydro-Electric Plant

The turbines for this development have the largest dimensions of any in the world to date (although not the highest capacity output). In the design are seen all the features of recent advances, such as (1) volute casing and draft tube molded in the concrete substructure, (2) cast-iron speed ring with the vanes serving as columns to support the concrete floor, generator and thrust-bearing loads from above, (3) lignum vitæ guide bearing, (4) Kingsbury thrust bearing located above the generator, and (5) pneumatic brakes acting on the generator rotor to bring the revolving parts quickly to a standstill.

load of the runner from above. Fig. 2 shows one of the thrust-bearing supports assembled on the shop floor of the makers. It is seen to consist of a twelve-faced cast-iron central hub and 12 cast-iron bridge arms bolted to it. These arms will be supported by and bolted to the top flange of the generator frame. The center hub weighs 85,600 lb. and each of the 12 arms 13,100 lb., making the assembled weight of the bridge 242,800 lb. The total weight of the revolving parts of the turbine and generator amounts to some 550,000 lb. The openings between the bridge arms are covered with steel plate so as to allow forced ventilation of the generator.

The speed ring is made in five sections bolted together, the assembled weight being 186,700 lb. The speed ring

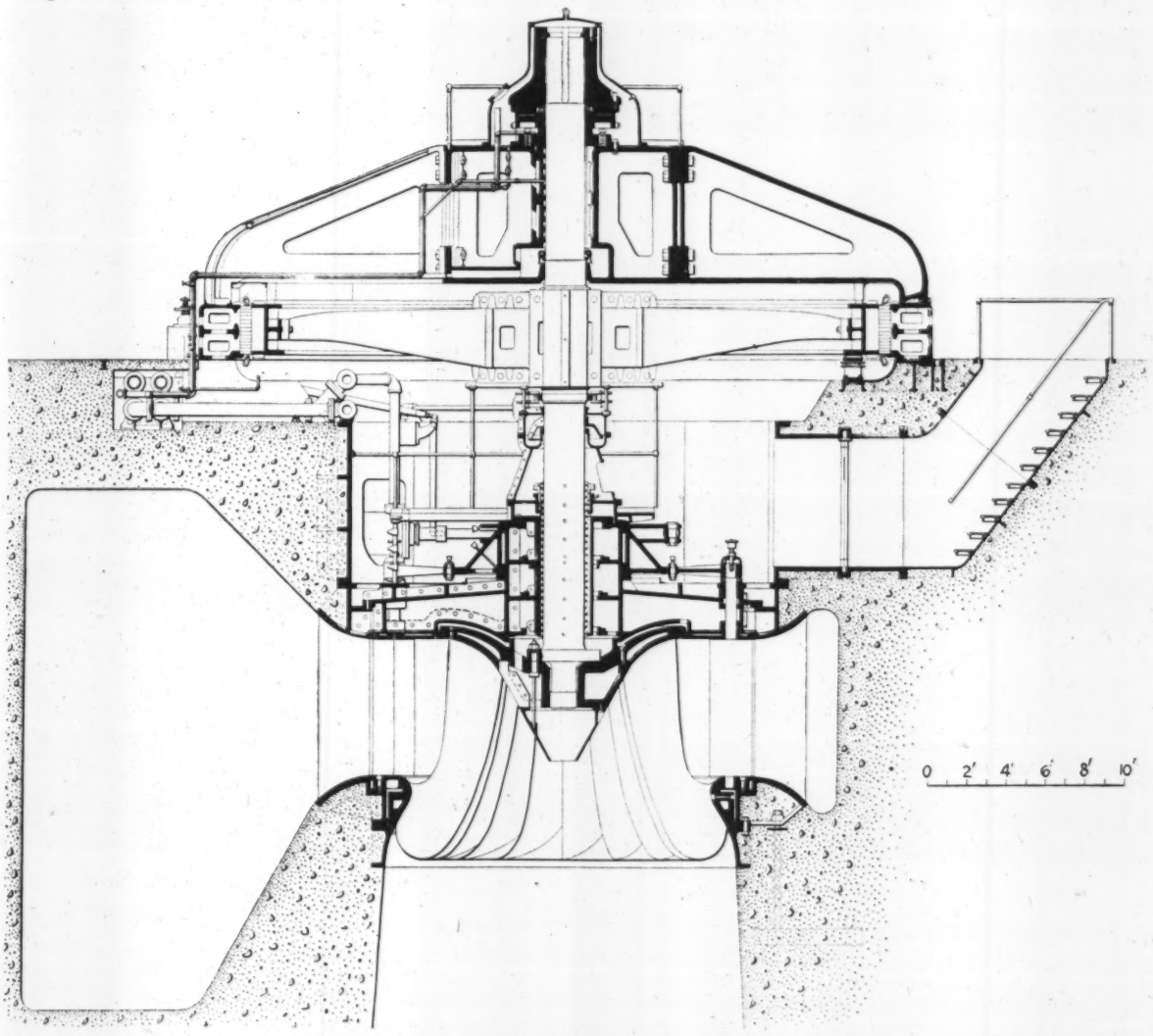


Fig. 1. Sectional Elevation of One of the Turbines at Cedars Rapids, Que.

Turbine Construction—The rated diameter of the runner is 11 ft. 10½ in. (on the center line of speed ring) and the speed is 55.6 r.p.m. The speed ring has an outside diameter of 24 ft. 12 in.; the generator is 37 ft. 4 in. overall. Other important dimensions may be scaled from Fig. 1. The nominal capacity is 10,000 hp.

The low rotative speed necessitates a very large diameter of generator rotor to secure proper peripheral speed and this somewhat increased the difficulty of supporting the

is 25 ft. overall diameter and 12 ft. 2 in. height. The size is appreciated from Fig. 1.

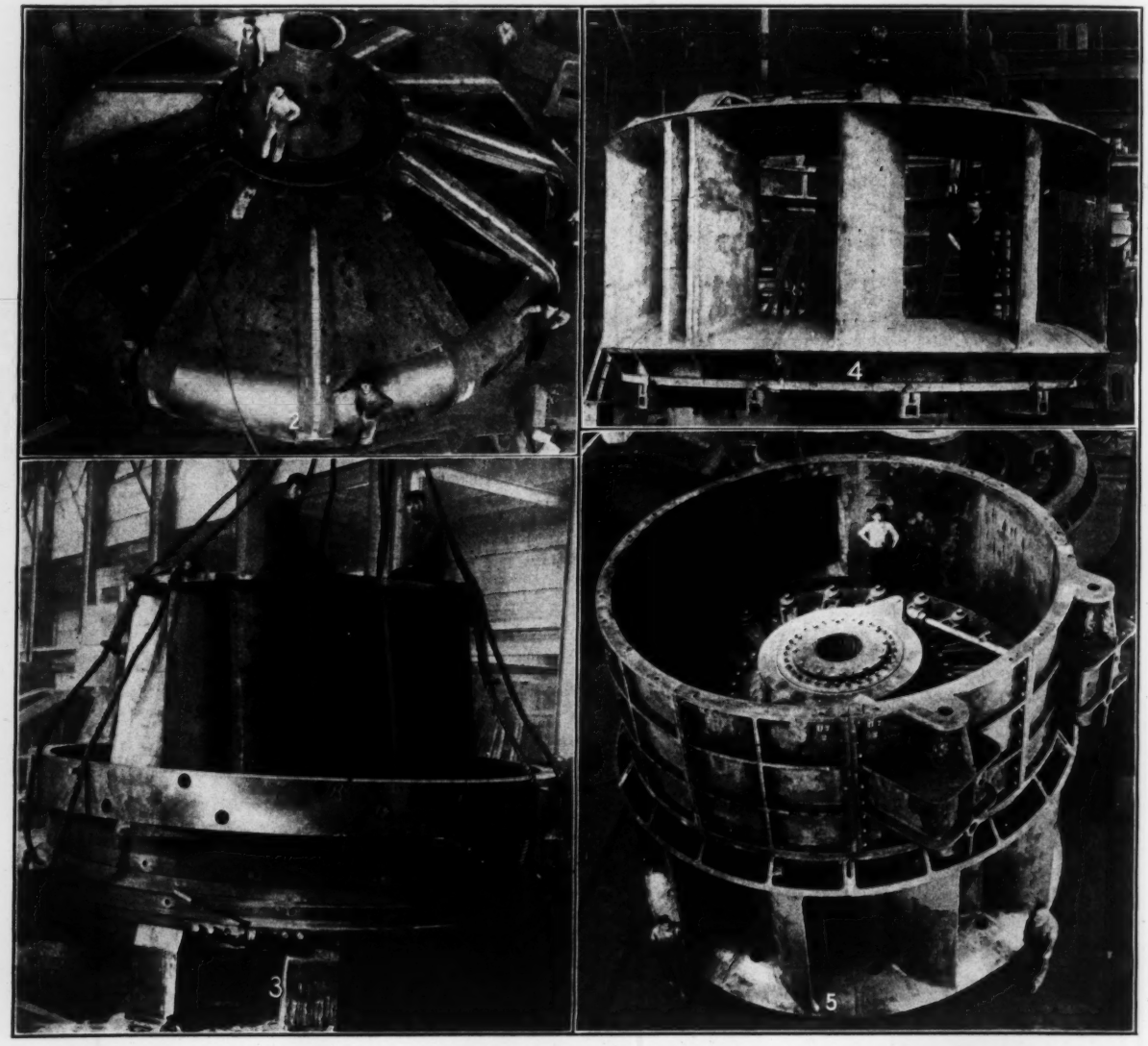
Normally the weight of the entire rotating parts of each unit will be carried by the Kingsbury bearing. It was intended to provide a small roller bearing within the Kingsbury and to come into play if the shoes of the latter began to wipe. Space has been left for the rollers but they will not be used unless experience should show their advisability. The roller bearing would not be large enough

to carry the load indefinitely, merely of sufficient size to operate long enough for the station operator to prepare for a shutdown.

The lignum vitæ guide bearing used is largely different from the old-fashioned bearings of that name, which consisted usually of three large blocks evenly spaced around the circumference of the shaft, each equipped with adjusting screws. With these the load was concentrated at the center of the block and gave rapid wear. Here lignum vitæ strips are dovetailed into the bearing boxes parallel to the axis of the shaft and with the end grain normal to the shaft surface. The bearing areas are made large enough so that the pressure per square inch on the strips is light and provision for adjustment is not necessary. Spaces are provided between strips for the circulation of cooling water. Bearings of this type have been successful in supporting propeller shafts of ships and have been also used in submerged turbine work. Their application, however, to unsubmerged bearings is of recent date. Clear water will be piped to the bearings in the same manner as oil is brought to the older babbitted type. The water escapes from the bearings into the draft tube and this eliminates all the difficulties which have been met with in leading away the oil from the babbitted bearings.

The iron turbine runner is cast in four parts on account of the greater ease of shipment and erection, and because of a greater assurance of sound castings.

The guide vanes are of cast steel with separate steel stems passing through them and keyed. This has been done to permit the removal of separate guide vanes without requiring the dismantling of the remainder of the unit. By coring out the interior of the vane a considerable reduction in weight has been possible without sacrificing strength. The operating levers at the upper ends of the guide-vane stems are connected to the operating ring through links, and the operating ring in turn is actuated by reach rods which are connected directly to the trunk pistons of the operating cylinders, there being two of the latter for each unit. The pressure on the pistons of these operating cylinders is controlled by the governors



FIGS. 2-5. SHOP VIEWS OF THE TURBINES FOR THE CEDARS HYDRO-ELECTRIC PLANT
(Fig. 2—Bearing Bridge; Fig. 3—Runner; Fig. 4—Speed Ring; Fig. 5—Operating-Ring Chamber)

located on the generator floor. (The governor is a direct-acting flyball design with sufficient inertia of flyballs to operate control valves, without intermediate mechanism. It is geared to the main shaft; the working fluid is water.)

The sections of the runner are held together by a cast-steel crown at the top, which incloses the four sections. A one-piece ring of cast steel surrounds the band runner at the lower end and is fixed to this band by bolts.

The velocity in the head race at low-water stage varies from 4 ft. per sec. above to 2½ ft. per sec. close to the power house. Velocity in the draft tube at the wheel discharge is some 15 ft. per sec., but this is reduced by the enlarging cross-section to about 4 ft. at the outlet.

The efficiency guarantees for the turbine were made under severe bonus and penalty clauses. Each main turbine is guaranteed to have a maximum efficiency of at least 87% when "operating under an effective head of 30 ft., running at a speed of 55.6 and developing between 10,000 and the maximum figure corresponding to wide-open gate, provided, however, that the maximum power does not exceed 10,800 by more than 5%." The results secured in the Holyoke testing flume with a miniature runner showed an efficiency slightly in excess of 90%.

AUXILIARY AND CONTROL EQUIPMENT—To each of the main turbines is connected a 10,000-kv.-a. three-phase 6600-volt 60-cycle generator of revolving field type. This is believed to be the lowest-speed large generator yet built and one of the largest in diameter. The rotating field spider consists of a cast-iron center, in two parts, and a steel rim, in four sections, with 136 bolted poles. The generator rotor weighs 213,000 lb. without shaft; the entire revolving element, including turbine runner, weighs 470,000 lb.

Each generator will receive 35,000 cu.ft. of air delivered to the wheel pit, which is closed in as already mentioned, so that a few ounces pressure can be maintained. To furnish this air, there are five sets of fans taking air through the tailrace wall and discharging into an air chamber in the substructure, from which ducts lead to the wheel pit of each unit.

To each of the three smaller turbines is connected a 1250-kv.-a. three-phase 2300-volt 60-cycle generator of the same type (except for higher speed—1500 r.p.m.). Each of the large generating units has its own motor-driven exciter set, comprising a 150-kw. 250-volt machine connected to a 225-hp. motor. The exciter voltage of each set is controlled automatically to maintain the voltage of the main unit. The 1250-kv.-a. units serving the exciters and auxiliaries in turn are excited from direct-current generators direct-connected and supported above the alternator. For the governor pumps there are four centrifugals, each driven by a 250-hp. motor.

As already noted,* the main station will be entirely a generating plant, no attempt being made to locate here the high-tension apparatus or control of the connections to transmission lines. In the main station there are two switchboards, (1) the main control desk for the operation of the large units and (2) a board for the control of the 2300-volt auxiliary generators and the motor-driven accessories. From the first of these boards will be operated all the oil switches in the main generator circuits and also the rheostats and field switches for the main machine. This board will be a desk type, at the back of and above which will be panels with the usual indicating instruments and one integrating watt meter for each main circuit.

Although the normal operating voltage in the power house for the main units will be 6600 volts, the generator-switch installation has been designed for 13,200 volts and so have all of the 6600-volt conductors. The 2300-volt circuit switches are designed to operate on up to 7500 volts and the 2300-volt conductors are insulated for 4400 volts.

In the generating station there is a bank of auxiliary transformers of 3000-kw. capacity made up of three 1000-kw. 6600/2300-volt units. This bank is connected to one of the main generating circuits and may be used to feed on to the 2300-volt auxiliary busbars to act as a spare capacity in case of shutdown of one or more of the 1250-kw. auxiliary generators. Other smaller

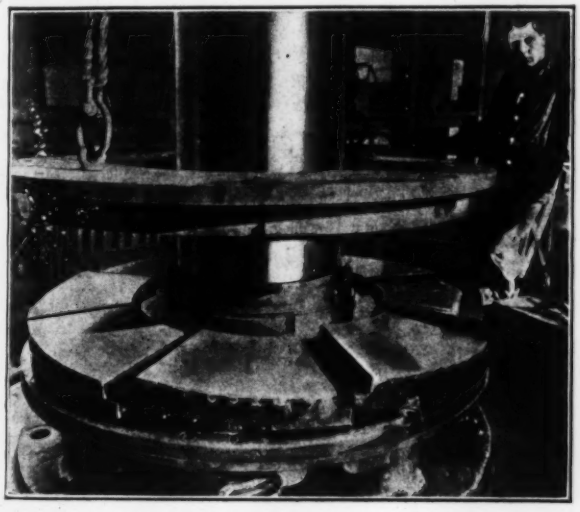


FIG. 6. KINGSBURY THRUST BEARING FOR CEDARS TURBINES

auxiliary transformers will furnish the low-voltage lines with current for miscellaneous light, heat and power.

The feeder cables between the generator switches and the low-tension busbars in the transformer house comprise four 300,000-circ.mils three-conductor paper-insulated lead-covered cables for each machine with provision for a fifth cable if found necessary. Special care was used for complete separation of the individual cables in individual ducts. Between the generating station and transformer house these are carried on a trestle, which will come out when the enlarged station is built.

In the transformer house on shore are the high-tension switches and feeders between transformers and transmission lines. Provision has been made for four transformer banks, two to be of 24,000-kv.-a. capacity and made up of 8000-kv.-a. single-phase 6600/110,000-volt units; the other two banks will be of 15,000-kv.-a. capacity, each bank having three 5000-kv.-a. single-phase 6600/66,000-volt units. The 110,000-volt banks feed transmission lines running to Messina, N. Y., where 60,000 hp. will be taken by the Aluminum Co. of America. The remainder of the power transmitted at 66,000 to Montreal, from the 15,000-kv.-a. bank. In the transformer house there will be a small bank of transformers for light, heat and power service about the premises generally.

*"Engineering News," Mar. 25, 1915.

The U. S. Lighthouse Service

By George R. Putnam*

SYNOPSIS—Safeguarding navigation by lights and other signals on the coasts of the United States is a branch of engineering work of which most engineers know little; but it employs a staff of nearly a hundred technical men directing the work of 5600 employees and expending nearly two million dollars per annum. Recent notable engineering work performed by this service is described by its official head.

The work of building and maintaining beacons and warnings for the guidance of mariners on the coasts of the United States and its possessions is done by the U. S. Lighthouse Service.

The variety and wide geographic distribution of these operations are indicated by a few of the works now in progress—a light and fog signal at Cape St. Elias, Alaska, a lighthouse on Navassa Island, West Indies, a lighthouse on Kauai Island, Hawaii, light and fog signal stations on submarine foundations in Delaware Bay and in Chesapeake Bay, and a system of lights and buoys for Livingstone Channel, Detroit River.

The chief officers of the Service are engineers, several of them being members of the American Society of Civil Engineers. At the headquarters of the Service in Washington are two engineering divisions, one under the Chief Constructing Engineer charged with the construction and upkeep of all fixed structures and the other under the Superintendent of Naval Construction charged with the construction and repair of all vessels and floating equipment.

The field service is divided into 19 districts, and the Inspectors in charge are technical men experienced in lighthouse or closely related work, and most of them are engineers by profession. Under these Inspectors is a construction force consisting in each district of one or more Superintendents, Assistant Superintendents and Aids. These are men educated and trained in civil, mechanical or marine engineering. The Aids enter the Service by passing an engineering examination, and are for the first years given various duties which will equip them for the technical work of the Lighthouse Service. The technical force above described and including draftsmen comprises about 93 persons, while the whole force of the Lighthouse Service is about 5600.

Last year the total expenditure of the Service for repairs and improvements was $1,337,067, and for new works $612,575, or a total of $1,949,642 for betterment expenses, this being one-third of the total expenditures for the Service.

The desirable distribution of lights and other aids along a coast depends on its maritime development and its physical characteristics, and is influenced by the prevailing meteorological conditions. Thus the north Atlantic Coast has a large foreign and coasting trade, and the shores are intricate and in part rugged, and along this coast the main lights are, with few exceptions, placed at such intervals that their arcs of visibility overlap. On portions of the coast of simple contour, and with smaller traffic, there are unlighted stretches between the lights which stand on the projecting capes.

*Commissioner of Lighthouses, Washington, D. C.

Recent New Lighthouses

The most powerful light recently established is that at Kilauea Point, on the north coast of Kauai Island, Hawaii. This was built to provide a landfall light for

Fig. 1. Kilauea Lighthouse, Hawaii

shipping bound to Honolulu from the Orient. The lighthouse is of reinforced concrete on rock foundation. The light is furnished by a 55-mm. oil-vapor lamp with focal plane 217 ft. above the water, and 37 ft. above the ground. The lens is composed of two groups of two panels each, and gives a double flash of 250,000 cp. every ten seconds. The keepers' quarters are in three separate stone dwellings. There is no fog signal, this coast being free from fog. The final cost of the station will be about $78,000.

The construction of the breakwater for Los Angeles Harbor, Calif., necessitated building a light and fog sig-

nal at its outer end. The station is located upon a monolithic block of concrete 40 ft. square, 20 ft. in height, with top 14 ft. above high water; this block was constructed as a part of the end of the breakwater, which is of riprap, and the end is in 51 ft. of water. The lighthouse has a structural-steel framework throughout. The first story is octagonal and covered with steel plates. The upper stories are cylindrical, and their exterior walls are covered with cement plaster on reinforcing metal, and the interior partitions are similarly constructed. Surmounting the tower is a helical bar lantern, in which is a bivalve flashing lens and oil-vapor lamp with focal plane 73 ft. above the water. The fog signal, housed in the same structure, consists of two 6-in. sirens, with compressed air supplied by duplicate direct-connected gasoline-engine-driven air compressors. The total cost was $35,971.

The improvement of harbors on the Great Lakes has necessitated the replacing of a number of lighthouses and fog signals by new structures. A recent instance is Superior Entry, Wis., where the main light and the fog signal are on the outer end of the new south breakwater. The duplicate, and consists of a diaphone, blown by compressed air supplied by direct-connected oil-engine driven air compressors. There is a stored-air reserve for immediate starting of the fog signal in case of necessity. The total cost was $53,357.

Lighthouses on Submarine Foundations

Eleven lighthouses in the United States have been built on submarine foundations, sunk into the sand by the pneumatic process, the first being that at Fourteen-Foot Bank, Delaware Bay, in 20 ft. of water. Another is 11 miles off the coast on Sabine Bank in the Gulf of Mexico, in 18 ft. of water. Another is now under construction at Thimble Shoal in Chesapeake Bay, to replace the screw-pile lighthouse on this shoal, which was wrecked by collision in 1909.

The foundation of this structure consists of a pier built up of cast-iron plates bolted together. The body of this pier is 30 ft. in diameter, spreading to 42 ft. at the base and 38½ ft. at the deck. It was assembled on shore near Norfolk, launched on a marine railway, towed

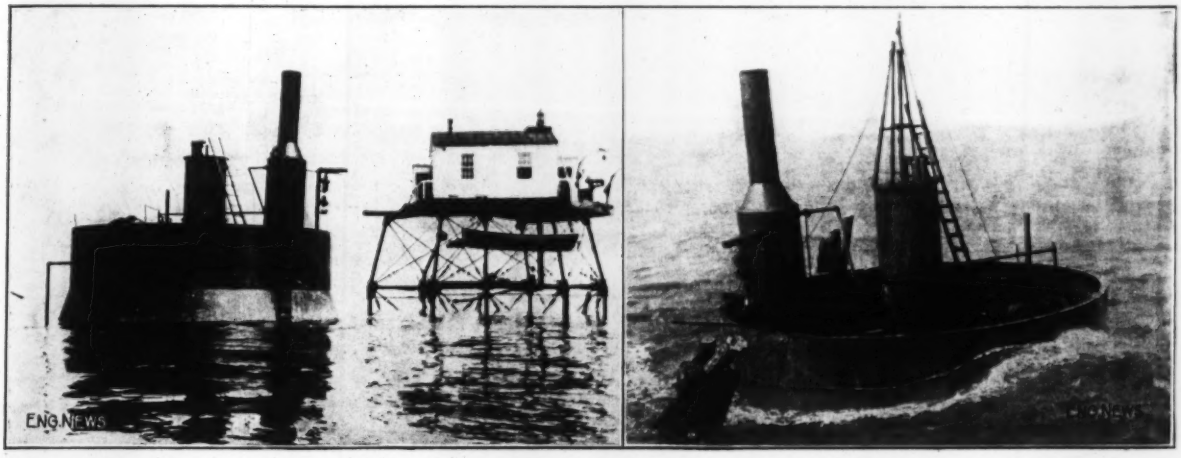


Fig. 2. Caisson for Thimble Shoal Light, Chesapeake Bay, Afloat Near Old Structur

structure is carried on a rectangular concrete base 11½ ft. high, rising from the level of the breakwater. Reinforced concrete is used throughout in the construction, with structural-steel framing to carry the floor and roof slabs of reinforced concrete. The tower is surmounted by a cast-iron deck and helical lantern, with the focal plane of the incandescent oil-vapor lamp 70 ft. above the water. The gasoline-engine-driven air compressors for sounding the fog signal are on the first floor, and living quarters on the second. The lights at the ends of the north breakwater and the two pierheads are automatic acetylene-gas lights on skeleton steel towers. The total cost of all these aids to navigation was $34,443.

It has recently been necessary to rebuild the Buffalo, N. Y., Breakwater light because of the decayed condition of the old structure. The old crib foundation was removed to a point 4 ft. below lake level. The base of the new building is of reinforced concrete, built on concrete blocks resting on the underwater crib foundation. The building is rectangular and is constructed of vitrified brick, with trim of granite. The oil-vapor lamp in a four-panel revolving lens is 65 ft. above lake level, and gives a flash of 180,000 cp. every 5 seconds. The fog signal is in

to the site, and sunk by the pneumatic process 12 ft. 9 in. into the sand bottom and filled with concrete. The deck supports a three-story conical cast-iron dwelling, upon the roof of which is the helical bar lantern whose focal plane is 55 ft. above high water. The fog signal consists of a trumpet, furnished with air by kerosene engines and compressors, which are placed in the basement within the pier. The appropriation for this structure was $107,000, most of which will be required.

An important bay lighthouse on Brandywine Shoal, in Delaware Bay, is now being reconstructed. The former lighthouse was supported by a screw-pile structure. The new lighthouse is wholly of reinforced concrete and consists of an unprotected cylindrical pier 35 ft. in diameter resting in 8 ft. of water upon the heads of wooden piles, which were jetted into the shoal so that their heads were 1 ft. above it. The reinforced-concrete pier was built on shore, launched, floated out to the site, sunk in position and secured upon the wooden piles by 12 reinforced-concrete piles passing through pockets in the outer annular shell of the pier. The concrete piles were secured within the pier by filling these pockets with concrete. Concrete was placed over the bottom of the shell and the cylinder

was then filled with sand and gravel. The deck and tower up to the lantern are of reinforced concrete.

Small Beacons

The new Livingstone Channel in the Detroit River has been marked with gas beacons and buoys throughout its length of 6½ miles, the lights being placed opposite each other and at intervals of about ½ mile, and with spar buoys intermediate between the gas buoys. The beacons consist of concrete piers 22x35 ft. in plan, with their ice breakers protected by steel plating, pointed upstream. In the construction of the beacons advantage was taken of the coffer-dam a mile in length which was built for the purpose of taking out the principal rock cut. The solid concrete foundations of six of the beacons were built in place in the dry before the coffer-dam was removed. Four other piers are reinforced-concrete caissons, built within the coffer-dam when it was dry, floated out after the water was admitted, and sunk in 12 to 14 ft. of water on their sites, which had previously been dredged clean to rock and covered with small stone to give an even and level bearing; the interior of the cribs was then filled with concrete. Two additional beacons in deeper water will rest on timber cribs capped with concrete blocks.

Reinforced concrete has also recently been used to some extent for foundations for small beacon lights in the water, using three, four or more reinforced-concrete piles and reinforced-concrete decks.

A new type of cast-iron mast for unattended automatic gas lights has been developed and installed on the Point Judith breakwaters, which in times of storm are sometimes swept by the sea to a depth of 10 ft. Each light structure is made up of a hollow cast-iron column 33 ft. long and 10 in. outside diameter, made in three sections. The columns are set 9 ft. into the breakwater and embedded in concrete. Around the top section, 20 ft. above high water, is a steel tank house 4 ft. in diameter for holding gas tanks. The acetylene lantern is mounted above this tank house. The columns are filled with concrete with reinforcing rods. The columns offer but a small surface to resist the waves and the tank house is above their reach; the structures have withstood severe storms and given satisfaction. The average cost of a beacon of this character with equipment was $2500.

Beacons with unattended automatically flashing gas lights have been established in inaccessible localities where the expense of complete lighthouses was not warranted at present. There are now 62 such beacons in Alaska; 15 of these during the year 1912 were installed at an average cost of $1387 each. Each beacon is provided with tanks storing sufficient acetylene gas to operate the light for about five months.

An interesting installation of this character is the acetylene-gas beacon placed in 1912 on Richardsons Rock, a storm-swept reef difficult of access, lying in 200 ft. of water and 21 miles off Point Conception on the California coast. This light is mounted on a steel skeleton tower 50 ft. in height. The cost was $3774.

A similar beacon has recently been placed on Redding Rock, lying about 4½ miles off the northern coast of California; this was even more difficult than at Richardsons Rock owing to the smaller size of the rock and the greater hazard of landing. This light is of 390 cp., and is carried on a 30-ft. steel skeleton tower, with focal plane 116 ft. about high water. The cost was $3202.

Unattended lights, using various types of gas apparatus or electricity, have been installed in recent years at a number of stations where there were previously resident keepers, but this has been done only at stations of subordinate importance and where there are no fog signals.

In the last four years 161 lights have been changed from oil to automatic gas or electric. Although some of these are in charge of keepers of other lights, yet by these changes there has been a saving in number of keepers of 44 and a saving in compensation of keepers of about $27,000 a year, besides lessened expense in other ways, such as upkeep of dwellings.

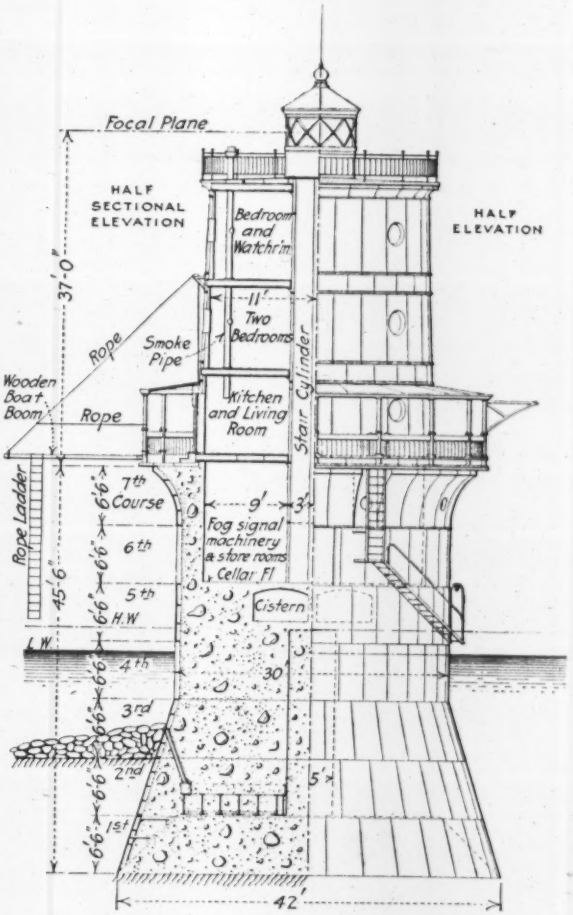


Fig. 3. Thimble Shoal Lighthouse, Half Vertical Section and Half Vertical Elevation

Alterations and Repairs

An instance of changes sometimes required in light towers is the lighthouse at North Point, Milwaukee, Wis., where on account of the growth of park trees the light became obscured from some bearings on the lake, and it was necessary to raise the focal plane 32 ft. This was accomplished recently by taking down the original tower, which was of cast iron lined with brick, and erecting on a new foundation a steel-frame subtower, incased in steel plates, and the cast-iron shell of the old tower and the old lantern were reërected on top of the new structural-steel subtower. The cost of the work was $9455.

The outer brickwork of some of the earlier lighthouse towers erected on the Great Lakes has disintegrated to

such an extent as to require repair. In several cases these brick towers have been protected by incasing them with steel plates riveted together and filled in with concrete.

Recently the brick lighthouse at Evanston, Ill., has been repaired by covering the tower with concrete and cement mortar over steel reinforcement. This tower is 102 ft. from the ground to the focal plane; the main portion is conical, 22 ft. diameter at the bottom, 13½ ft. at the top and 77½ ft. high, above which are the cylindrical portions of the tower, watchroom, etc. All paint and disintegrated brick and mortar were first removed from the exterior, and it was thoroughly wet with water. The conical portion was provided with reinforcement consisting of ½ in. diameter mild-steel vertical rods spaced 24 in. c. to c. and horizontal circular rods of the same size spaced 14 in. c. to c. outside the vertical rods, the former being blocked out from the brickwork 1¾ in., and all wired together and lapped at the ends. The conical portion of the tower was then surrounded by forms, leaving a space of 3½ in. between them and the tower, and the concrete was deposited within this space. After the forms were removed the fresh surfaces of the concrete were rubbed down. The cylindrical portions of the tower were covered with expanded metal blocked out from the brickwork and secured in place by wiring to expansion bolts set into the brickwork, and this entire surface was then plastered with cement mortar. The cost of the work was $2650.

Improvements in Lighting Apparatus

There has been steady progress in the United States in improving the lights, particularly in the matter of giving a distinguishing characteristic to lights that were originally fixed, or improving the characteristic and increasing the candlepower of existing lights. Thus in the past four years 140 lights have been changed from fixed to flashing or occulting, and the number of stations equipped with oil-vapor lamps has been increased from 80 to 268, or 235 per cent. Practically all the principal coast lights are now equipped with oil-vapor lamps.

An improved type of incandescent oil-vapor lamp has been designed and put into service. Two sizes are in general use, one with mantles 35 mm. and the other 55 mm. in diameter. There has also been installed a lamp with a cluster of three 55 mm. lamps. The intensities of these bare lamps are 600, 1500 and 2500 candles, and the oil consumption 450, 900 and 2200 gal. per annum, respectively. Thus the annual consumption of oil is from 0.6 to 0.88 gal. for 1 cp., whereas with the oil-wick lamps 4.8 to 7.6 gal. per annum were required for 1 cp.; the increase in illuminant efficiency is, therefore, about eight times.

The lamps are made up in units known as the single-tank and double-tank systems. In the former, which is now coming into general use, the kerosene and compressed air are in one tank; in the latter separate tanks are employed. The kerosene is forced to the lamp by the pressure of the compressed air. The lamp consists simply of an outer casing and base containing an annular vaporizer, the various parts of a bunsen burner and a mantle. The oil upon entering the vaporizer is at first vaporized by an alcohol flame in the base of the case. After the vapor is ignited the heat from both burners within the lamp is sufficient to keep it going without the alcohol flame. The oil vapor upon leaving the vaporizer passes through a strainer and a very small nozzle, and is then mixed with the proper amount of air in the heating tube supporting the bunsen burner, and burns with an intense blue flame, bringing the mantle to a brilliant white heat.

Although only one shore station, Navesink, N. J., is equipped with electric light for which current is generated at the station, at 30 minor stations electric lights are used, either incandescent or arc, obtaining current from an outside source, usually a city electric service. Where such lights have a characteristic other than fixed, it is obtained either by a revolving lens, by some make-and-break electric device controlled by clockwork or by some occulting device driven by a motor.

Protection from Shore Erosion

Shore-line erosion must be contended with in the maintenance of lighthouses on certain portions of the coast, and presents serious problems, often requiring prompt and vigorous action to prevent the destruction of valuable property. In some instances the original lighthouse has been undermined and destroyed or endangered, rendering necessary the construction of a new tower. Thus, three successive towers have been built at Cape Charles at the entrance to Chesapeake Bay. The lighthouse at Hunting Island, South Carolina, was built of iron plate so that it could be taken down. Although originally placed a quarter of a mile from the shore, the sea encroached so that after thirty years the tower was taken down and reconstructed over a mile back from the shore. During recent years more systematic effort has been made for shore protection in cases of erosion near lighthouses.

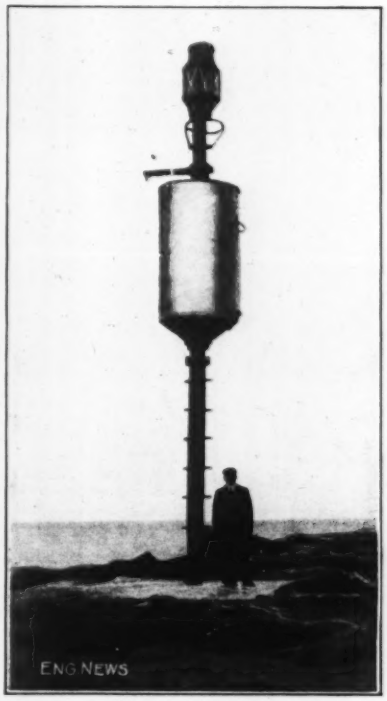


Fig. 4. Beacon on Point Judith Breakwater

At Cedar Point, Md., in the latter part of 1912, about 210 ft. of concrete wall and four riprap jetties in timber cribs, averaging 30 ft. in length, were constructed on the east and south sides, at a cost of $3338. Since then the breach has been making up. Additional reinforced-concrete groins on the north side are under construction.

At North Manitou, Mich., in October, 1912, the fog-signal plant was in imminent danger of being destroyed. The combined force of two tenders was required to save the building from being undermined. Five stone-filled cribs were hastily constructed, most of the timber being obtained at the site. These cribs varied from 8 to 12 ft.

in width, and the longest extended about 60 ft. from the shore. At the end of a month the beach had filled in between the cribs and extended 60 ft. beyond at some points. The cost was $1395.

At Cove Point, Md., shore protection consisting of 340 ft. of concrete wall and four riprap jetties in timber cribs, averaging 30 ft. in length, was completed in 1912 at a cost of $3897.

The results of these works in most instances indicate that the shore erosion is either overcome or greatly retarded, but the works are too recent for final conclusions to be drawn.

Where the currents run approximately parallel to the shore the most dependable means of protecting a beach from erosion appears to be the use of low groins parallel with the profile of the beach, extending out at right angles to the current, from a point a little above high water to a point as far as practicable beyond low water.

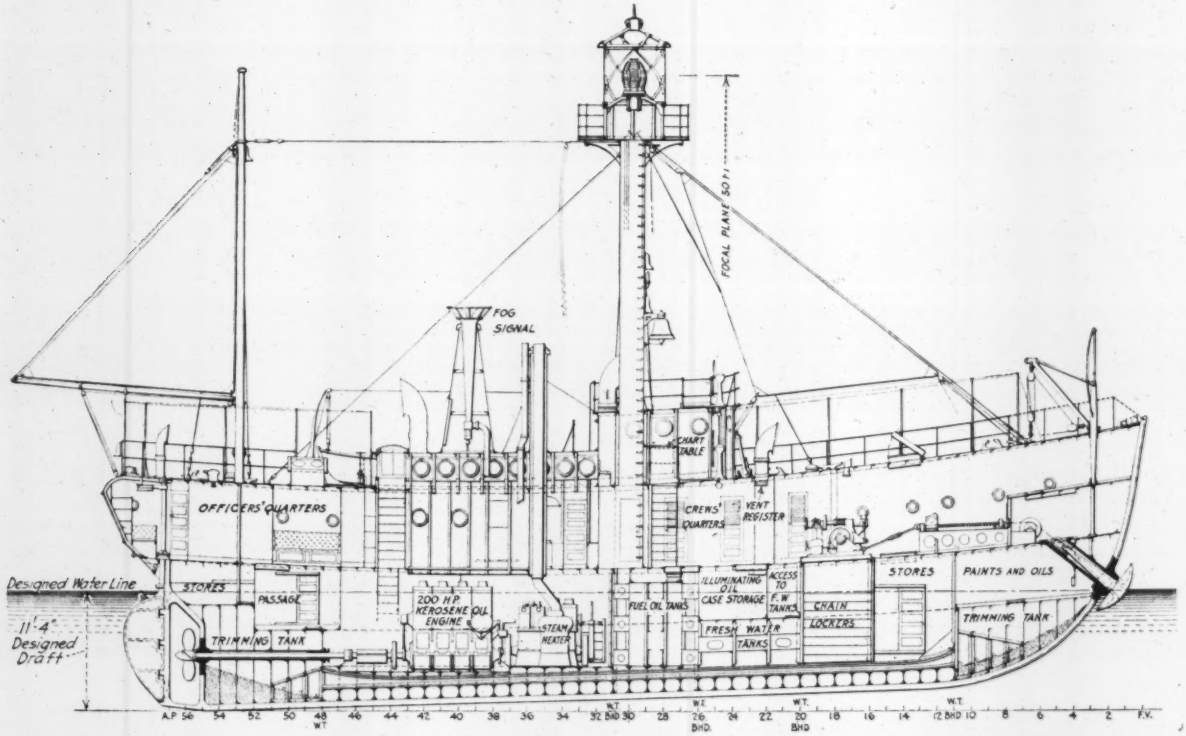


FIG. 5. DESIGN FOR U. S. LIGHT VESSELS NOS. 101 AND 102, INBOARD PROFILE

FLOATING BEACONS

Of the 14,200 aids to navigation maintained by the Lighthouse Service more than half are floating on the water, moored in position. There are 453 gas buoys, an increase of 228 in the last four years. These buoys are for the most part operated by charges of oil gas or acetylene gas under pressure, and will burn for a number of months on a single charge. The increase in the number of gas buoys has been of great benefit to navigation. Less expensive gas buoys are now being developed for use in shoal water.

Light vessels are now maintained on 52 stations, and there are 14 additional relief vessels. These are the most expensive types of beacon to maintain, the direct annual expense of the light vessels amounting to about $700,000. The vessels on the more exposed stations have self-propelling machinery, and three of them are equipped with wireless telegraph.

Recent light vessel design is illustrated by the preliminary plans for a light vessel to be used as a relief on the Atlantic Coast. This vessel will have a length of 92 ft. on water line, a beam of 25 ft. and draft 11 ft. 4 in. For increased safety a flush-deck construction is adopted; there are five watertight bulkheads, and the vessel is built of steel and noncombustible materials throughout. The propelling engine will be about 200 hp., internal combustion, oil-burning and direct reversible. The light will be oil vapor or gas, and will be carried 50 ft. above the water in a lantern accessible through the single tubular mast on which it is mounted. The light will be capable of being made flashing or fixed to duplicate the characteristic of the station ship relieved. The fog signal will be a siren using compressed air, and also a submarine bell; the air will be supplied by duplicate air compressors driven by internal-combustion oil engines. The use of oil fuel for power instead of coal will obviate much of the difficulty experienced in keeping light vessels supplied with fuel, and will permit the vessel to remain longer on a station.

In addition to the light vessels, the Lighthouse Service maintains 45 lighthouse tenders for the purpose of placing, supplying and caring for the light ships, buoys and other aids to navigation. The maintenance of these tenders costs about a quarter of the expenditures for the Service. On an average one or two vessels must be built each year to replace those worn out in service. The light vessels and tenders together make a fleet of 112 vessels.

FOG WARNINGS

The distribution of fog signals along the coasts has conformed to the needs imposed by fog conditions and the

extent of traffic. The average number of hours of fog for a year decreases from 1057 hours on the coast of Maine to 180 hours on the south Atlantic and Gulf Coasts.

Along the Atlantic Coast from Cape Lookout northward there are 328 fog signals, out of the total of 567 maintained by the Service. There is a moderate amount of fog on the Great Lakes, the average being 351 hours a year during the season of navigation, and there are 127 fog signals on the American shores of the Lakes. Portions of the Pacific and Alaskan Coasts are extremely foggy; these coasts are at present provided with 83 fog signals. There are no fog signals in Porto Rico or Hawaii, where fog is rare.

The principal fog signals used are air sirens, steam whistles, reed horns, bells controlled by clockwork, and submarine bells operated by compressed air. Several other types of fog signals have been experimentally installed and are being tried out, including the sireno (an electrically driven blower siren), the diaphone (a form of siren with reciprocating piston) and the acetylene-gas fog gun. Installations are in progress with a view to testing the use of wireless telegraphy as a fog signal, but no results are as yet available.

There are in use 13 fog bells operated electrically from the shore, which are found advantageous in making it possible to place the actual fog signal in an exposed position, as at the end of a breakwater, and permitting its distant control by a keeper on shore.

The principal recent improvements in fog-signal equipment have been in connection with having them sounded more promptly on the approach of fog. Progress has been made in this line by a more extended use of oil engines and compressed air, improvements for starting engines promptly and by the storage of compressed air.

A Point in College Hydraulic-Laboratory Design

By William T. Lyle*

In designing hydraulic laboratories for colleges too much emphasis has been placed on the need for high heads. The object of this brief article is to show that a considerable number of experiments, including the most essential ones, can be performed with low heads.

The discharge of a water pipe, for example, is not dependent on the *pressure* in the pipe but rather on the *difference of pressure* between the sections where the piezometric measurements are made. While a wide range of heads is desirable, an ample supply of water is much more preferable. Under favorable conditions a laboratory may be located near a stream, across which a low dam can be constructed to furnish the required head and quantity; or an old mill property may be acquired for the purpose. A very large number of experiments may be performed in such a laboratory and, with a liberal quantity of water, they may be carried out on such a scale as to make the results of real practical worth.

With low heads experiments may be performed with the orifice, the Venturi meter, the weir, rotary and disk meters, water pipes and conduits, and the turbine.

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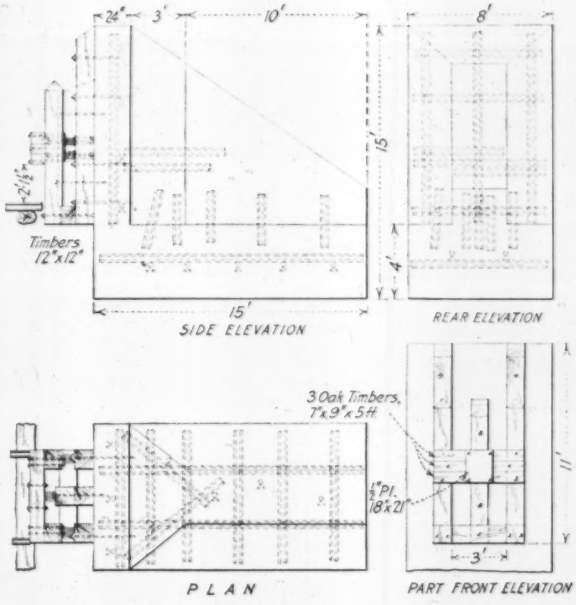
High Concrete Bumping Blocks; B. & O. R.R.

Concrete bumping blocks have been used extensively for tracks abutting on public streets. As a rule, these are only high enough to engage the car couplers, but the bumpers used on the Chicago terminal division of the Baltimore & Ohio R.R. are peculiar in being carried to a height of nearly 10 ft. above the rails, while the total height from base to top is 15 ft. The purpose is to secure such a massive and weighty block that it cannot be shifted by the impacts of cars. Concrete bumping blocks of the smaller class have in many cases been displaced by the shocks to which they are subjected, and have remained a source of danger as it is almost impossible to restore them to true position.



High Reinforced-Concrete Bumping Block for Heavy Service

The B. & O. design is shown in the accompanying illustration. The base is 15x8 ft. and 4 ft. thick, with a front wall of the same size and 2 ft. in thickness. Behind this wall the body of the block is reduced in size, as shown. It is heavily reinforced with old rails, utilizing such scrap pieces as may be available in each case. The bumper contains 36.3 cu.yd. of concrete and 152½ ft. of 60-lb. rails.

A timber framing against the face of the block forms a backing for a bumping post proper, and the drawing shows nests of car springs to absorb the shock. These springs are omitted in recent construction, as their maintenance (under such severe service conditions) involved considerable expense, and it is doubtful if they were of much benefit to the cars.

The blocks are placed at the ends of inclined team tracks, to prevent cars from running into the street. In several cases they have accomplished their purpose, having stopped cars which had got beyond control of the train crew. The cost of the bumping block complete is about $300.

Annual Municipal Clean-Up Week in Philadelphia

The accompanying views are both interesting and instructive in showing what the Bureau of Highways in Philadelphia is doing to arouse enthusiasm in municipal street cleaning and in municipal cleaning-up in general. The first four views were taken on the occasion of the annual street-cleaners' parade, just about a year ago. The enthusiasm and efficiency of these street cleaners are rather the more remarkable because they are contractors' laborers and not municipal employees.

Realizing the need of hearty coöperation on the part of the public, the Chief of the Bureau of Highways, Wm. H. Connell, does some extraordinarily active publicity work to advertise the coming of a clean-up week. To this end the usual methods of interesting various civic and business-men's associations are resorted to, but perhaps the most effective means is the sending out of advance notices to manufacturers of and dealers in brooms, sweepers, rakes, shovels and every other implement used in house, yard and alley cleaning.

By thus awakening their business instincts all the large department-store managers and dealers are persuaded to concentrate their advertising for a few days chiefly to

CLEAN-UP WEEK IN PHILADELPHIA, SPRING OF 1914

these utensils, so that the clean-up campaign is temporarily the most important feature in the local newspapers.

The lower two views show typical heaps of rubbish collected in 1914, the sum total of which surpassed all expectations—no less than 140,000 cu.yd. of rubbish over and above the normal yearly collections.

The one great drawback in this work is that the city still disposes of its rubbish on dumps, but this is not the fault of the Bureau of Highways, which has long advocated the erection of uptodate disposal plants that can eventually be taken over by the city. The contractors will not erect disposal plants under present conditions because of the short-term agreements which the law requires.

Poor Sand the Cause of the Rapid Disintegration of a Sheet-Asphalt Pavement

By Walter M. Cross*

During the latter part of 1911 and the early part of 1912, a sheet-asphalt pavement was laid on Fifteenth St. in Kansas City which, when dry, was excellent, but when the street was dirty and saturated by melting snow it rapidly disintegrated. The surface mixture of the pavement would appear to be thoroughly soaked with water, and its mineral aggregate had the appearance of nearly uncovered sand, which was so poorly cemented together while wet that it could readily be picked to pieces with the point of a lead pencil.

Such parts of the surface of the pavement as were not disintegrated by traffic while in this condition again became very hard when the pavement dried out—so hard that it could be cut out only with as much difficulty as is experienced in removing a first-class asphalt surface mixture. When dry this surface would neither crack during the very cold weather nor become excessively marked during warm weather. It resisted abrasion to a satisfactory degree.

The sand from which this surface mixture was made was from a recently opened pit and was unusually red in appearance—about as red, or slightly more so, than Kettle River sandstone. The sand appeared to be clean, was sharp and so fine that it was necessary to mix it with 10 to 15% of coarse sand to obtain a satisfactory grading.

After the addition of 15% of limestone dust, about 14% of the surface mixture was 200-mesh material, of which about one-half was filler. There was from 25 to 30% of 100- and 80-mesh sand and 12 to 18% of 30-, 20- and 10-mesh sand, the remainder being 40- to 50-mesh. The amount of asphaltic cement in the mixture was from 10.3% to 10.7%. This asphaltic cement was a mixture of equal parts of Gilsonite and Cuban native asphalt fluxed with a heavy Texas oil to a penetration of about 72° Dow.

Exactly the same asphaltic cement used with other sands produced an asphaltic surface mixture first-class in every particular, as has been proved by the experience of several years. That part of the same pavement made of an asphaltic surface mixture of a similarly graded sand from another source was faultless.

In repair work done by the municipal asphalt plant of Kansas City, which was for a time using sand from this same pit mixed with Texaco asphaltic cement, the pavement was destroyed by water in precisely the same way. When the municipal plant used this same Texaco asphalt on a clean mineral aggregate from another source, there followed no disintegration by water.

The writer has personally observed that test samples made of this red sand and Texaco asphaltic cement became rapidly disintegrated by water, while samples similar to these in every way, except that clean sand from a different source was used, were good after being immersed in water continuously for three months. Similar experiments were made on Trinidad Lake asphalt fluxed with a paraffin oil prepared from Kansas crude oil, with like results. Surface mixtures made in the laboratory with California asphalts and this reddish sand were also promptly disintegrated by immersion in water.

The sand, upon examination, was found to contain a considerable quantity of hydrated (or hydrous) silicate, which would form hard particles when heated, but when again wet the particles would lose all of their cementing value. A fairly hard sand conglomerate made with this material was almost instantly disintegrated when dropped into water.

This reddish sand, when run through the drying drum of an asphalt plant, was to a considerable extent converted into very small conglomerates which would pass a 10-mesh screen. When made into asphaltic surface mixture, it appeared to be most satisfactory under ordinary observation. Even in the laboratory, routine examination of samples of surface mixture containing these small conglomerates showed nothing strange, for they were broken up in the process of dissolving the asphaltic cement out of the mixture, and thus the screen test of the mineral aggregate showed nothing of the defect.

Pats of such surface mixture when broken open showed no mud balls since the conglomerates were, when dry, so firmly cemented that none of them could be broken by pulling the pat to pieces. These same pats when placed in water over night were completely disintegrated on account of the popping open of these small conglomerates and to a large extent the breaking of the bond between the asphaltic cement and the sand.

Other asphalt pavements which were affected to a much less degree by prolonged action of melting snow and sloppy mud were examined by the writer, and in every case there were found very small conglomerates composed of the finer parts of the mineral aggregate. The conglomerates were not broken open so as to be seen when the compressed asphalt surface was fractured. They did break open and destroy the cementing value of the asphalt surface after soaking in water for several days.

Further effort was made to prove this tendency of very small conglomerates formed during the drying of the mineral aggregate to cause the scaling of an asphaltic surface mixture by testing some of this mineral aggregate. While hot the sand as served to the mixer was run through a section of a drum containing enough pebbles to clean all the large sand grains and to destroy any conglomerates. Surface mixture made of this treated sand was subjected to the most severe conditions, both on the street and by prolonged soaking in the laboratory. No disintegration or abnormal surface softening occurred.

It is believed that the subject is of enough importance to other cities to warrant a very careful examination of sand to be used in asphalt paving mixtures for any tendency of the material to form conglomerates when dried.

*City Chemist, Kansas City, Mo.

Wind Stresses in Skew Bridges

By J. P. J. Williams*

The stresses in skew portals and the shears and bending moments in the end-posts of skew bridges are generally treated by an approximate method which neglects the component of the wind force acting on the portal in the direction parallel to the main trusses. The following more exact treatment develops by rational assumptions and static laws of equilibrium a series of working equations for:

1. Reactions Due to Wind on Top Chords.
2. Stresses in Upper Lateral Truss.
3. Stresses in Portal with Diagonal Bracing.
4. Stresses and Bending in End-Posts.
5. Stresses in Main Truss Members.
6. Stresses in Lattice Portal.
7. Stresses in A-Frame Portal.
8. Stresses and Bending in End-Posts with A-Frame Portal.
9. Stresses in Lower Lateral Truss.
10. Stresses Due to Wind on Train.

The five-panel single-track skew span shown in Fig. 1 will be used in developing the equations desired, all dimensions being as given on that figure.

Assume the origin of coördinates X, Y, Z to be at O, at the elevation of the points of contraflexure of the end-posts, and in the farther truss. The usual assumption for the points of contraflexure is halfway up from the bottom of the end-post to the lower strut of the portal bracing when the end-posts are considered fixed-ended in the direction perpendicular to the plane of the main trusses; this assumption is also made in the present article.

1. Reactions Due to Wind on Top Chords

Consider Fig. 1 with wind loads acting on all upper-chord joints in the direction indicated on the plan view of the upper laterals. The four unknown reactions at the supports are composed in general of three components each (H, R and W, with the distinguishing subscripts shown), thus making twelve unknowns in the problem of external equilibrium. Of course the problem is statically indeterminate, since there are but six equations of static equilibrium:

$$\Sigma X = 0 \qquad \Sigma M_x = 0$$
$$\Sigma Y = 0 \qquad \Sigma M_y = 0$$
$$\Sigma Z = 0 \qquad \Sigma M_z = 0$$

Let

w = Normal wind pressure, lb. per ft., on *both* upper chords ($\frac{1}{2}w$ on each chord);

N = Number of equal panels of length p, on the center line of the span;

s = Total skew, assumed to be the same at both ends;

W_t = Total wind load on both chords = $(N\text{-}1)wp$, with center of gravity on the center line of the span;

h_o = Vertical distance from top chord to points of contraflexure (if bases of end-posts cannot be considered fixed in the direction perpendicular to main truss, h_o becomes equal to the total height h).

*Chautauqua, N. Y.

Using the law $\Sigma Z = 0$ and the symmetrical relation of loads and reactions, we get

$$W_1 = W_2 = W_1' = W_2' = \tfrac{1}{4}W_t \qquad (1)$$

Also *assume* by law $\Sigma M_y = 0$ that

$$H_1 = H_2 = H_1' = H_2' = 0 \qquad (2)$$

By the law $\Sigma Y = 0$ and symmetry about the Z-axis we know that

$$R_1 = R_2' \qquad (3)$$
$$R_2 = R_1' \qquad (4)$$

Now applying the law $\Sigma M_x = 0$, noting that the moments of the horizontal reactions W are balanced by fixing moments at the bottom of the end-posts, there results

$$R_1 + R_2 = W_t \frac{h_o}{b} \qquad (5)$$

Then by the law $\Sigma M_z = 0$

$$(R_1 + R_2')\frac{l+s}{2} - (R_1' + R_2)\frac{l-s}{2} = 0$$

Or, using equation (3) and (4),

$$R_1(l+s) - R_2(l-s) = 0$$

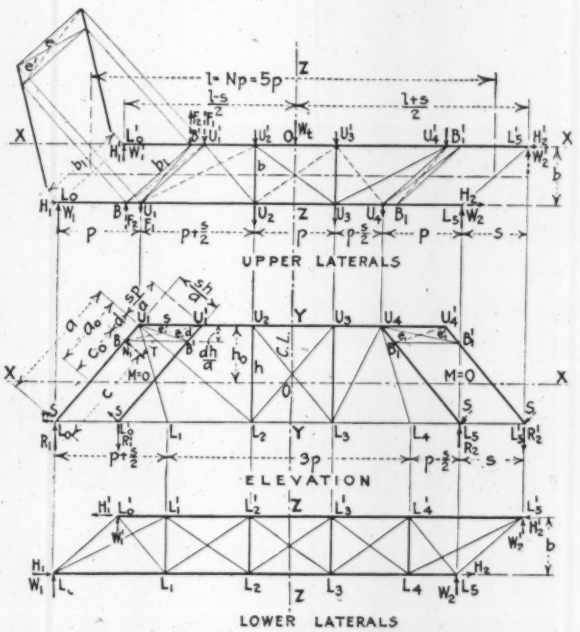


Fig. 1. Skew Bridge with Simple Portal

which with equation (5) gives

$$R_1 - R_2 = -\frac{s}{l}(R_1 + R_2) = -\frac{s}{l}W_t\frac{h_o}{b}$$

Adding equation (5) and solving for R_1,

$$R_1 = \frac{W_t h_o}{2b}\left(1 - \frac{s}{l}\right) = R_2' \qquad (6)$$

Subtracting from equation (5) and solving for R_2,

$$R_2 = \frac{W_t h_o}{2b}\left(1 + \frac{s}{l}\right) = R_1' \qquad (7)$$

2. Stresses in Upper Lateral Truss

When the wind load on the upper chords is specified as a fixed load, all *intermediate* total panel loads are wp, and there are N-3 such loads acting with their center of gravity at the center line of the span. Assuming, as

usual, that the diagonals act in tension only, the *net* reactions at U_1' and U_4' will be:

$$\left.\begin{matrix}\text{At } U_1', & W_{r_1} \\ \text{At } U_4', & W_{r_2}\end{matrix}\right\} = \frac{N-3}{2} wp \left(1 \pm \frac{s}{(N-2)\,p}\right)\left\{\begin{matrix}(8)\\(9)\end{matrix}\right.$$

Then the stress in the end diagonal will be:

$$Stress\ U_1'U_2 = W_{r_1}\left(\frac{length\ U_1'U_2}{b}\right)$$

and the other web stresses can be found from the shears in the usual way.

If the specifications prescribe a *moving* uniform load on the upper chords, the maximum wind-load stresses can be found by the conventional method. Thus,

Let

n = Number of full joint-loads between the end and the panel considered.

V = Maximum shear in the panel = end reaction at U_1'.

$$V = \frac{nw}{2\,(N-2)}\left[(n+1)\,p + s\right]$$

The maximum web stresses can be found from these shears in the usual manner.

3. Stresses in Portal with Diagonal Bracing

Consider the portal with diagonal bracing as in Fig. 1, assumed capable of developing only tensile stress in the diagonals (only one diagonal at a time being under stress). With the wind acting in the direction shown, diagonals $U_1\,B'$ of left portal and $U_4\,B_1'$ of right portal are stressed. The stress in the latter is the same as the stress in the other diagonal $U_1'B$ of the left end portal when the wind is reversed, and can therefore be used to obtain that stress without the necessity of considering reversed wind.

Stress in strut B B' by law $\Sigma Z = 0$ *at joint B*—

Let

F_1 = Force parallel to the Z-axis developed at U_1 by the bending action of W_1 acting at L_0;

F_2 = Similar force acting at B;

a_o = Distance from U_1 along the end-post to the point of contraflexure;

c_o = Distance from B to the point of contraflexure, usually $\frac{1}{2}c$;

$$K = F_2/b \qquad (10a)$$

Remembering the effect of the fixing moment at L_0, the forces F_1 and F_2 are obtained by moments about B and U_1 respectively:

$$F_1 = W_1\frac{c_o}{d} = \frac{W_1 c_o}{4\,d} \qquad (10b)$$

$$F_2 = W_1\frac{a_o}{d} = \frac{W_1 a_o}{4\,d} \qquad (10c)$$

The compressive stress in strut $B\,B'$ can now be found from its known Z-component, F_2, by the well-known method of ratio of length of member, b_1, to length of its Z-projection, b. Therefore,

$$Stress\ BB' = -F_2\frac{b_1}{b} = -Kb_1 \qquad (10)$$

Stress in strut U_1U_1' *by law* $\Sigma Z = 0$ *at joint* U_1'—The horizontal forces parallel to the Z-axis acting inward at U_1' are the joint load $\frac{1}{2}w\left(p - \frac{s}{4}\right)$, the reaction W_{r_1}, and the force F_1. These inward forces are balanced by the outward Z-component of the compressive stress $U_1\,U_1'$. Therefore

$$Stress\ U_1U_1' = -\left[\frac{w}{2}\left(p - \frac{s}{4}\right) + W_{r_1} + F_1\right]\frac{b_1}{b} \qquad (11)$$

Stress in diagonal U_1B' *by law* $\Sigma Z = 0$ *at joint* B'—Let

e = True length of the diagonal $U_1\,B'$;

e_1 = Projection of this length e on main truss plane;

e' = True length of other diagonal $U_1'\,B$;

e_1' = Projection of this length e' on main truss plane.

Then, by Fig. 1,

$$e = \sqrt{b^2 + e_1^2} \text{ and } e_1^2 = \left(\frac{sh}{a}\right)^2 + \left(\frac{sp}{a} - d\right)^2 \qquad (12a)$$

$$e' = \sqrt{b^2 + (e_1')^2} \text{ and } (e_1')^2 = \left(\frac{sh}{a}\right)^2 + \left(\frac{sp}{a} + d\right)^2 \qquad (14a)$$

The forces acting horizontally in the direction of the Z-axis at B' are: F_2 produced by the bending action of the end post, F_2 acting in the same direction produced by the compressive stress in strut $B\,B'$, and the required balancing Z-component of the stress in the diagonal, which must thus be $2\,F_2$. Therefore the tensile stress is:

$$Stress\ U_1B' = +2\,F_2\frac{e}{b} = +2\,Ke \qquad (12)$$

Stress in strut $U_4\,U_4'$ *or strut* $U_1\,U_1'$ *for reversed wind*—Considering joint U_4', by analogy with equation (11):

$$Stress\ U_4U_4' = -\left[\frac{w}{2}\left(p + \frac{s}{4}\right) + W_{r_2} + F_1\right]\frac{b_1}{b} \qquad (13)$$

A comparison of this equation with equation (11) shows that stress U_1U_1' is the larger, as it can be proved that;

$$Stress\ U_4U_4' = -\left[stress\ U_1\,U_1' - ws\left(\frac{N-3}{N-2} - \frac{1}{4}\right)\right] \qquad (13a)$$

Stress in diagonal U_4B_1' *or diagonal* $U_1'B$ *for reversed wind*—Considering joint B_1', by analogy with joint B', the Z-component is $2\,F_2$. Thus:

$$Stress\ U_4B_1' = +2\,F_2\frac{e'}{b} = +2\,Ke' \qquad (14)$$

4. Stresses and Bending in End-Posts

The end-posts are subjected to bending and shearing forces in both directions. Considering first L_0U_1, the bending perpendicular to the plane of the main truss is of course produced by the horizontal reaction W_1 at L_0. The bending in the plane of the main truss is produced by the stress in the strut BB', which is not perpendicular to this plane.

End-Post L_0U_1—

Let

N_1 = Bending component of stress BB' normal to L_0U_1.

T = Stress-increment component of stress BB' parallel to L_0U_1.

$$K_1 = K\frac{s}{a} \qquad (15)$$

The horizontal component of stress BB' parallel to the X-axis will be $F_2\frac{s}{b} = Ks$ by ratio of projections, since the component parallel to the Z-axis is F_2. The values

of the components N_1 and T can then be found by the triangle of forces shown at B;

$$N_1 = Ks\frac{h}{a} = K_1 h \tag{16}$$

$$T = Ks\frac{p}{a} = K_1 p \tag{17}$$

Shears and maximum bending moments in L_0U_1—In the direction perpendicular to the main truss, the shear below B is W_1, and above B is F_1. The bending moment is maximum at B, and in this direction has the value;

$$M_{max.} = W_1 c_0 = \frac{W_t}{4} c_0 \tag{18}$$

In the plane of the main truss, the shear below B is

$$S = N_1 \frac{d}{a} \tag{19}$$

Above B the shear is $N_1\frac{c}{a}$. The maximum bending moment in this direction also occurs at B, and its value is

$$M_{max.} = Sc \tag{20}$$

Stress L_0B by law $\Sigma Y = 0$ at joint L_0—By including the vertical component of the shear S acting at L_0, this stress is

$$Stress\ L_0B = -\left(R_1\frac{a}{h} + S\frac{p}{a}\right) \tag{21}$$

Stress BU_1 by joint B—The stress increment at B along the end-post is T, downward, and therefore the compression above B is decreased by that amount, or

$$Stress\ BU_1 = -\ (Stress\ L_0B - T) \tag{22}$$

End-Post $L_0'U_1'$—The shears and bending moments in this member depend upon the forces acting at joint B' since there is a resultant force acting at this point tending to bend the end post in the plane of the main truss. The forces acting at B' are: The compression in strut PB' which has a Z-component of F_2, the force produced by the bending action of W_1' at the base, and the tension in the diagonal U_1B'. By equation (12) and ratio of lengths, the component of this diagonal stress acting in main truss is $2Ke\left(\frac{e_1}{e}\right) = 2Ke_1$.

The normal upward component of this diagonal stress perpendicular to the end-post is, by ratio of lengths, $2Ke_1\frac{sh}{ae_1} = 2K\frac{sh}{a}$. This is twice the value of N_1 as given by equation (16). Since the stress in the strut BB' develops a *downward* normal component equal to N_1 in the plane of the main truss, the resultant normal force acting at B' is an *upward* bending component of $2N_1 - N_1 = N_1$, exactly as for the case of the other end-post L_0U_1. Therefore the bending moments and shears for end-post $L_0'U_1'$ are exactly the same in this direction as for end-post L_0U_1. They are also the same in the transverse direction, since the value of the horizontal bending force W_1' is the same.

The direct-stress component of diagonal stress U_1B' upward along the end-post, by ratio of lengths, will be;

$$2Ke_1\frac{d - \frac{sp}{a}}{e_1} = 2Kd - 2K\frac{sp}{a} = 2Kd - 2T$$

[See equation (17)]

Combining this value with the upward component T of the stress in strut BB', the resultant stress increment at B' is upward with a value of $2Kd - T$.

Stress $L_0'B'$ by law $\Sigma Y = 0$ at joint L_0'—By noting that the vertical component of the shear S acts in the opposite direction to the reaction $R_1' = R_2$, there results;

$$Stress\ L_0'B' = +\left(R_2\frac{a}{h} - S\frac{p}{a}\right) \tag{23}$$

Stress $B'U_1'$ by joint B'—Using the upward stress increment at B' just determined,

$$Stress\ B'U_1' = -(Stress\ L_0'B' - (2Kd - T) \tag{24}$$

End-Posts L_5U_4 and $L_5'U_4'$—The stress in the strut B_1B_1' for the right portal being the same as stress BB' for the left end, the shear and bending moment downward in the end-post L_5U_4 are the same as the upward bending moment and shear in L_0U_1 in the plane of the main truss. Perpendicular to that plane the values are also the same as for L_0U_1, since the force W_2 is the same as W_1. The analysis for the normal and longitudinal components at B_1' of end-post $L_5'U_4'$ can be made exactly as in the case of end-post $L_0'U_1'$. The projection of length e' on the main truss plane, i.e., e_1', has the same *normal* projection as the other diagonal, i.e. $\frac{sh}{a}$. Therefore the final resultant normal force at B_1' is N_1 downward, and hence the shears and bending moments are the same as for the other end-posts.

The upward longitudinal component of the stress in diagonal U_4B_1' is;

$$2Ke'\frac{e_1'}{e'}\frac{d + \frac{sp}{a}}{e_1'} = 2Kd + 2K\frac{sp}{a} = 2Kd + 2T$$

[See equation (17)]

Combining this with the downward longitudinal component T of the compression in strut B_1B_1', the resultant stress increment at B_1' is $2Kd + T$ upward. The following equations can therefore be given:

$$Stress\ L_5B_1 = -Stress\ L_0'B'$$

$$Stress\ B_1U_4 = -\ (Stress\ L_5B_1 + T) \tag{25}$$

$$Stress\ L_5'B_1' = +Stress\ L_0B$$

$$Stress\ B_1'U_4' = +[Stress\ L_5'B_1' - (2Kd + T)]$$

$$= +\ (Stress\ BU_1 - 2\ Kd). \tag{26}$$

For the case of relatively large skews, the stress $B_1'U_4'$ may become compression.

5. Stresses in Main Truss Members

Consider the case shown in Fig. 1. The stresses in the lower chords and web members of the main trusses due to wind on the top chords can be found as follows

End lower chords by law $\Sigma X = 0$ at end joints—Noting the effect of the shear S, and the relations between the end reactions, the equations for end lower chord stresses will be:

$$Stress\ L_0L_1L_2 = +\left(R_1\frac{p}{h} + S\frac{h}{a}\right)$$

$$= -\ (stress\ L_5'L_4'L_3') \tag{27}$$

$$Stress\ L_0'L_1'L_2' = -\left(R_2\frac{p}{h} - S\frac{h}{a}\right)$$

$$= +\ (stress\ L_5L_4L_3) \tag{28}$$

The intermediate chord stresses can be obtained from the main truss shear found below and the chord increment method. However, for all practical cases it is sufficiently accurate to assume all lower-chord stresses due to

wind on top chords to be equal in magnitude and of the value:

$$Stress\ L_0-L_5 = +\frac{W_1 h_o p}{2\,bh} = -(stress\ L_0'-L_5') \quad (29)$$

Stresses in main web members by the shear method—A vertical section passed through the near truss and curving out through the left portal gives a constant vertical shear equal to the reaction R_1 minus the vertical component of the acting diagonal U_1B' of the end portal. This vertical component of the stress in the diagonal can be found by ratio of its vertical projection $\frac{dh}{a} = \frac{dh_o}{a_o}$ to its length e multiplied by the stress (equation 12), using equation (10c) for F_2. Therefore

$$Vertical\ component\ of\ U_1B' = 2\,\frac{W_1 a_o}{4\,d}\,\frac{e}{b}\,\frac{dh_o}{a_o e} = \frac{W_1 h_o}{2\,b} \quad (30)$$

And the constant vertical shear will be:

$$V = R_1 - \frac{W_1 h_o}{2\,b} = \frac{W_1 h_o}{2\,b}\left(1 - \frac{s}{l} - 1\right) = -\frac{W_1 h_o s}{2\,b\,l} \quad (31)$$

It will be noticed that this shear is one-half the difference between the end reactions R_1 and R_2, as it should be, because this difference is balanced by the equal vertical components of the stresses in the end portal diagonals.

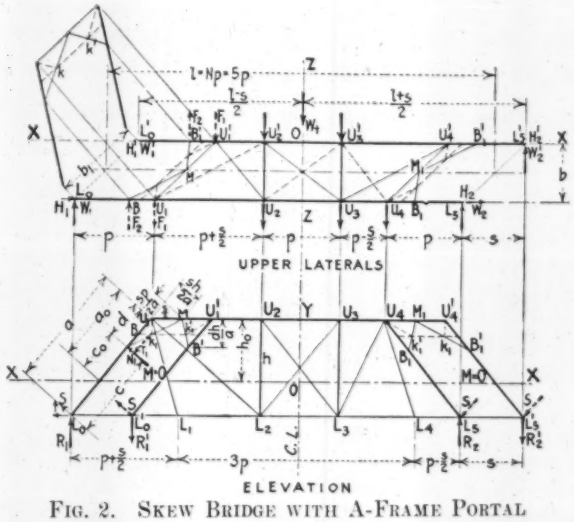


FIG. 2. SKEW BRIDGE WITH A-FRAME PORTAL

The stresses in the main web members can be found in the usual manner from the shear V, but it will be found that the values are relatively so small as to be negligible.

6. STRESSES IN LATTICE PORTAL

If a latticed portal consisting of several panels of multiple intersection diagonals be used, the preceding equations for maximum stresses in the top and bottom struts can be applied without sensible error by neglecting the effect of kneebraces (except as they affect the position of the point of contraflexure and the bending moment) and of the small components of the stresses in end diagonals at joints B, U_1', etc. Assuming m diagonals, of length f each, to be cut by the vertical section through the portal, the diagonal stresses can be found at once from the known constant vertical shear across the portal given by equation (30) and the constant vertical projection of the diagonals $\frac{dh}{a}$ or $\frac{dh_o}{a_o}$. Assuming each diagonal to take its proportional share of the shear, there results after reduction:

$$Diagonal\ stress = 2\,\frac{Kf}{m} \quad (32)$$

This equation is seen to check by analogy with equation (12) for diagonal stress in the preceding case of a single diagonal.

7. STRESSES IN A-FRAME PORTAL

This type of portal, shown in Fig. 2, is a common and efficient form. The members shown dotted are assumed to take no stress. Using methods exactly similar to those used in the preceding analysis, with the following notation, the stresses can be written at once.

Let

k = True length of diagonal MB;
k' = True length of diagonal MB';
k_1 = Projection of length k on plane of main truss.
k_1' = Projection of length k_1 on plane of main truss.

Applying the law $\Sigma Z = 0$ to joint B or B_1',

$$Stress\ MB = -F_2\,\frac{k}{\frac{1}{2}\,b} = -2\,Kk = +stress\ M_1B_1' \quad (33)$$

By analogy:

$$Stress\ MB' = +2Kk' = -Stress\ M_1B_1 \quad (34)$$

Applying the same law $\Sigma Z = 0$ to joint U_1', it is seen that stress in strut $U_1'M$ is the same as that in strut $U_1'U_1$ of the first analysis given by equation (11); also stress in strut $U_4'M_1$ is the same as stress $U_4'U_4$ given by equation (13). The stresses in the other top members MU_1 and M_1U_4 will be tensile and of less amount than the preceding values (as can be seen by applying law $\Sigma Z = 0$ to joints U_1 and U_4) and need not be considered, since for reversed wind the strut MU_1 gets compression equal to $U_4'M_1$ and strut M_1U_4 gets compression equal to $U_1'M$.

8. STRESSES AND BENDING IN END-POSTS WITH A-FRAME PORTAL

End-Post L_0U_1—The component of the stress in the diagonal MB which acts in the plane of the main truss is $2Kk\,\frac{k_1}{k} = 2Kk_1$ downward, and the component of this force acting normally to bend the end-post is

$$2\,Kk_1\,\frac{sh}{2\,ak_1} = K\,\frac{sh}{a} = N_1 \quad [\text{See equation (16)}]$$

Therefore the normal bending force is the same as in the first analysis, and stress L_0B and shears and bending moments are the same as before.

The stress in the upper part of L_0U_1, however, will differ because the longitudinal stress increment downward along the end-post at B is

$$T_1 = 2\,Kk_1\left(\frac{d + \frac{sp}{2\,a}}{k_1}\right) = 2\,Kd + K\,\frac{sp}{a} = 2\,Kd + T \quad (35)$$

Therefore

$$Stress\ BU_1 = -[Stress\ L_0B\ by\ equation\ (21) - T_1] \quad (36)$$

End-post $L_5'U_4'$ has exactly the same bending moments and stresses (in tension) as end-post L_0U_1.

End-Post $L_0'U_1'$—As the reaction at L_0' is the same, and inspection of the forces at B' indicates that there is

also the same upward normal bending force N_1, producing the same shear as before, the stress $L_0'B'$ is the same as in the first case, given by equation (23). The stress $B'U_1'$, however, results from a different upward longitudinal stress increment at B' of

$$T_1' = 2Kd - T \tag{37}$$

Therefore

$$Stress\ B'U_1' = +(Stress\ L_0'B'\ by\ equation\ (23)\ -T_1') \tag{38}$$

End-post L_5U_4 has the same shears and bending moments, and stresses in compression of equal magnitude to the tension in $L_0'U_1'$. Thus the shears and bending moments in all end-posts, and also the lower-chord stresses, will be exactly the same as for the first portal type analyzed.

9. Stresses in Lower Lateral Truss

Assuming first that the diagonals are designed to take tension only, the values of the net reactions can be written by analogy from equations (8) and (9) obtained for the upper lateral truss.

Let

w_1 = Wind load per foot on lower lateral truss.

Then,

$$\left.\begin{matrix} Reaction\ at\ L_0' \\ Reaction\ at\ L_5' \end{matrix}\right\} = \frac{N-1}{2} w_1 p \left(1 \pm \frac{s}{l}\right) \left\{\begin{matrix} \\ \end{matrix}\right. \quad \begin{matrix} (8b) \\ (9b) \end{matrix}$$

These reactions can then be used in the usual manner to find shears and web stresses, and also the chord stresses by the chord-increment method, assuming fixed loading and span fully loaded for maximum stresses.

If moving wind load is specified, of course the chord stresses are the same as before, but the web stresses must be computed from the maximum shears, using the conventional method. By analogy with equation (8a), the following general value for maximum shear V can be given:

$$V = \frac{n w_1}{2N} [(n+1)\, p + s] \tag{8c}$$

Assume second that the diagonals are designed to take both tension and compression, as is generally the case when they are connected to the stringers. For this case it is sufficiently exact to assume the end reactions and shears to be the same as for a square span of length $l = Np$ on the center line and that the Z-components of the stresses in the two diagonals of any one panel are equal. The maximum chord stresses are then computed by the coefficient chord-increment method with bridge fully loaded. The maximum web stresses for moving uniform load are found by the conventional method for shears by the following equation, which is exact enough for practical purposes:

$$Shear\ V = \frac{n\,(n+1)}{2N} w_1 p$$

$$Stress\ in\ diagonal = \frac{V}{2} \frac{(length\ of\ diagonal)}{b}$$

10. Stresses Due to Wind on Train

The overturning effect of wind on train produces vertical panel loads on the main trusses and stresses in all main members. The only stresses which need be considered, however, are those in the end-posts and the lower chords, which are maximum for span fully loaded.

Let

w_T = Uniform load, lb. per ft., acting on train, usually taken as 400 lb. acting at a height of 7 ft. above top of rail.

h_T = Vertical distance of wind on train above plane of lower laterals.

$W_T = (N-1)\, w_T p$ = total *net* wind load on train.

Then net end reactions, by analogy with equations (6) and (7) will be

$$\left.\begin{matrix} R_1 = \\ R_2 = \end{matrix}\right\} \frac{W_T h_T}{2b} \left(1 \mp \frac{s}{l}\right) = \left\{\begin{matrix} R_2^1 \\ R_1^1 \end{matrix}\right. \quad \begin{matrix} (6a) \\ (7a) \end{matrix}$$

The end-post stresses are then found from these reactions by multiplying by $\frac{a}{h}$, and the end lower-chord stresses by multiplying by $\frac{p}{h}$. The intermediate chord stresses can be computed by the chord-increment method, each vertical panel load being $w_T p \frac{h_T}{b}$.

In all cases, the final combination of wind-load stresses with dead- and live-load stresses in the main truss members is to be made in exactly the same manner as in the case of a square span, noting that the end-posts must be designed to safely develop the maximum combined stresses due to bending in *both* planes in addition to the total direct stress.

The foregoing equations can be used for trusses with inclined upper chords in the same way that square spans are treated.

Methods and formulas for finding angles and lengths for detailing skew portals are given in Engineering News of Feb. 11, 1909.

New Water-Filtration Plant, Quincy, Ill.*

By W. R. Gelston†

The original water-filter plant at Quincy, Ill., one of the earliest mechanical-filter plants in the country (built about 1891), was abandoned Sept. 1, 1914, when the new water-purification system was put in place. The new plant consists of mixing chambers, settling tanks, six 1,000,000-gal. filter units and two small clear-water tanks.

Two complete coagulating, mixing and sedimentation units are provided, so connected that they may be operated in parallel, in series or independently. One unit provides for two-thirds and the other for one-third of the total capacity.

Our short experience with this plant leads us to believe that the best results can be obtained by the series method of operating. The plant is therefore being operated as follows: The low-service pumps discharge into an open forebay where the water is treated with the first dose of sulphate of alumina. It then travels about 400 ft. over and under the concrete baffles in the mixing chambers and finally passes through sluice gates into sedimentation basin No. 2. This basin is 27x94x20 ft. deep, and is provided with a vertical concrete baffle which extends nearly the entire length of the basin on the center line. When the plant is operating at a 6,000,000-gal. rate this basin pro-

*From a paper read at the Illinois Section of the American Water Works Association, March, 1915.

†Superintendent, Citizens Water Co., Quincy, Ill.

vides a travel of about 175 ft. and a period of 1½ hours for sedimentation.

From the outlet side of this basin the water is drawn from the surface, over a weir, through a large sluice gate, and passes through a concrete flume to the second forebay. Here it receives its second dose of alum, as it begins its tortuous passage through the mixing chambers connected with basin No. 1. This basin is 55x94 ft. in plan, and 20 ft. deep, with one vertical concrete baffle on the center line around which the water must pass. The sedimentation period in this basin is about three hours, making 4½ hours for both basins. The water passes from the outlet side of this basin to the filters.

Steel storage tanks, for coagulating solutions, are provided in duplicate for the alum and lime. A small electric motor is used to stir the solutions constantly to keep them of uniform strength. The coagulant feed is accomplished by means of constant-head orifice boxes, the solution flowing by gravity from the orifice boxes to the forebays.

A complete hypochlorite sterilizing plant is also installed in duplicate. This solution flows by gravity and it is introduced into the filtered water as it passes through a 24-in. pipe line on its way to the high-service pumps.

The six filters are grouped three on each side of the pipe gallery. They have a sand area 12x32 ft. and are 10 ft. deep. The strainer system is designed for combined air-and-water wash. The strainers are covered to a depth of 12 in. with graded gravel and the sand has a depth of 30 in. Ottawa sand of 0.38-mm. effective size is used. The filters are equipped with loss-of-head gages, hydraulic-operated valves and the Simplex type of rate controllers.

Two clear-water basins beneath filter beds provide storage capacity for 160,000 gal.

There is a well equipped water-works laboratory, located in the head house, having a total floor area of 625 sq.ft.

The original designs for this plant were prepared by D. W. Mead and C. V. Seastone, consulting engineers, of Madison, Wis. The contract for the construction of the plant was awarded to the New York Continental Jewel Filtration Co. and this company sublet the building construction to the Coddington Engineering Co., of Milwaukee, Wis. Carl Francis was resident engineer for the filter company during the construction period. Gilbert Pratt was in charge of its operation during the official efficiency test, which was conducted by W. F. Langelier of the Illinois State Water Survey. Valuable assistance was also rendered by Edward Bartow and Paul Hansen (of the State Water Survey) in the preparation of the plans and the final award of the contract.

Results of a Water-Waste Survey at Washington, D. C.—The daily water pumpage of Washington increased from 44 to 66 million gallons between 1896 and 1906 and the daily per capita consumption from 161 to 217 gal. Pitometer surveys were started in 1906 and the force increased until in 1912 forty men were operating eleven pitometers. The elimination of leakage and waste at the close of the work had reduced the daily pumpage by 11 million gallons and the per capita consumption to 151 gal. The investment in operating cost in the latter period of the work amounted to $32,000 per year, but the waste elimination represented a 57% return upon the investment.—From a paper by Paul Lanham, Pitometer Operator, Washington, D. C., before the Indiana Sanitary and Water Supply Association.

Electric-Air Brake Adopted by Pennsylvania R.R.

It has recently been announced that electro-pneumatic brakes would be used by the Pennsylvania R.R. for passenger-service equipment in place of the air brakes now used. Cars in service will be equipped as rapidly as opportunity and available funds permit. It is well known that the action of air brakes is serial, the brakes being applied first on the engine and first car, then on the second car and so on. About 8 sec. elapse from the time application is started on the engine until full braking force is secured at the end of a 12-car train. The use of all-steel cars, weighing 120,000 lb., gave more severe shocks and surges in the train than could be well tolerated.

The new brake differs from the old type mainly in that the control of the application of compressed air is by an electric circuit which extends the length of the train.* All brakes are applied at the same instant on all the cars. The full braking power of the equipment is exerted throughout the length of the train 2 sec. after the engine-man has made application.

To try out this equipment before its adoption, in 1913, an extensive series of tests was made jointly by the Pennsylvania R.R. and the Westinghouse Air Brake Co. on the Atlantic City division of the West Jersey & Seashore R.R., near Absecon Station, where there is a level high-speed stretch of track. (Some details were presented in the paper "Brake Performance on Modern Steam Railroad Passenger Trains," by S. W. Dudley, before the American Society of Mechanical Engineers, February, 1914.) The trials occupied three months, in which time 691 stops were made from speeds varying up to 80 mi. per hr.

Among the multitude of results secured several are of unusual interest. The shortest emergency stop of a single car without locomotive and running at 60 mi. per hour was made in 725 ft. The shortest stop from 80 mi. per hour was made in 1422 ft. This was with a modern steel passenger coach and is the record for stopping a railroad car. The shortest stop of a locomotive and train of 12 such cars from a speed of 60 mi. per hr. was made in 1021 ft. The shortest stop of this train from a speed of 80 mi. per hr. was made in 2197 ft. These figures show that the braking distance has been reduced by a third, in addition to eliminating the shocks and surges of older equipment. A train weighing 2000 tons can be stopped gently in 1000 ft.—practically its own length.

*The earlier electro-pneumatic brake, developed by the Westinghouse company for the existing New York subway cars, was described in "Engineering News," Feb. 20, 1912. The newer system (types "U. C." and "A. M. U. E.") differs materially from the old, which had triple, magnet and vent valves, main tanks, auxiliary and supplementary reservoirs, brake cylinder, no-voltage release, motorman's air- and electric-control valve, compressor, master governor, reservoir pipe, brake pipe and electric governor, release, application, emergency and supply train lines. For the new subway cars of the New York Municipal Ry. Corporation, the new system is being furnished, there being a universal valve (with air and electric sections), main tanks, emergency, service and auxiliary reservoirs, brake cylinder, motorman's control valve (air and electric), compressor, master governor, brake pipe and electric supply, emergency, application, release and governor train lines. This is somewhat simpler. The superseded Pennsylvania car equipment (Westinghouse type P. M.) in its essential parts comprised a brake pipe, quick-action triple valve, brake cylinder and auxiliary reservoir. The new outfit comprises the brake pipe, universal valve, brake cylinder, service, emergency and auxiliary reservoirs, the electric release, application, emergency, governor and battery (positive and negative) train lines and a battery. The locomotives used with this rolling stock will require only a new engineman's valve, or the attachment of the electric contacts to the old valves, and the proper plugs and receptacles for the train lines.

Low-Water Bridges Over Torrential Streams, Bexar Co., Texas

By Terrell Bartlett*

Bexar County, Texas, the county-seat of which is San Antonio, the largest city of the state, has adopted a definite policy of replacement of all temporary bridges on main roads by concrete structures. The total amount which is being expended for concrete bridges at the present time is $200,000, which will provide permanent structures at about 10% of the main road stream crossings within the county.

The streams in the northern part of the county are in comparatively shallow beds, and the roads have heretofore approached by easy grades and crossed on ordinary fords. Usually these streams have little or no water in them, but occasionally torrential floods come down from the hills above with crests from ten to even twenty feet deep. The average frequency of these rises is probably not over two in a year, and the crests pass within a few hours. A considerable afterflow remains, however, which in the past has caused serious inconvenience to automobiles for two or three months and has absolutely interrupted traffic at the old fords for a period ranging from three to six weeks after each storm.

For eleven of these crossings a low-water type of bridge has been adopted. These structures are entirely submerged by the crest of the floods, and traffic is interrupted for from twelve to twenty-four hours. Sufficient openings are provided under the low bridges to carry a considerable flow, and in addition the bridge floor is made absolutely level so that the roadway forms a passable ford even with the openings filled and a sheet of water 12 or 15 in. deep over the top. These low bridges will serve to carry the

*Of Bartlett & Ranney, Consulting Engineers, San Antonio, Tex.

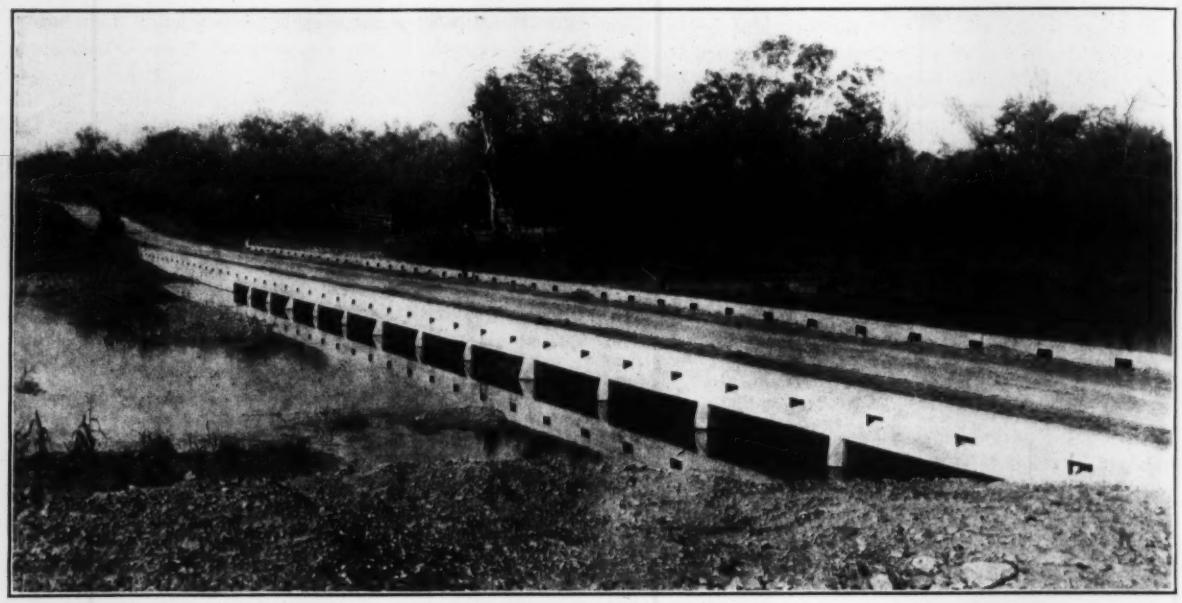


Fig. 1. The Austin-Salado Low-Water Bridge, Bexar County, Texas

(Designs for this bridge, made by the Bexar Co. authorities, were approved by the U. S. Office of Public Roads; the structure forms a part of the San Antonio-Austin Post Road now being built by the United States Government)

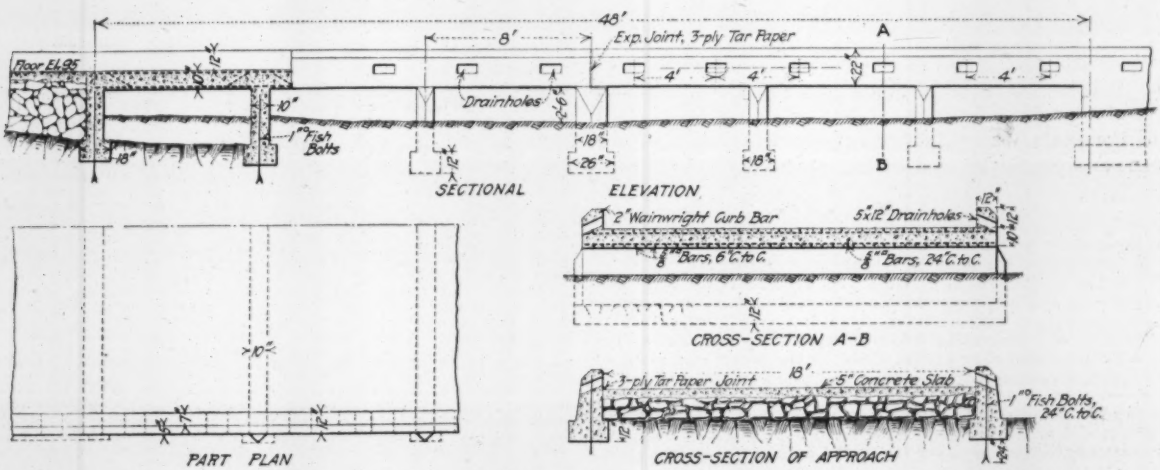


Fig. 2. Details of Leon Bridge No. 2, Showing Typical Low-Water Bridge with Rock Footing

traffic over the afterflow of the large rises and over all small rises, and traffic will not be stopped except for a short period during the crest of floods.

All of the low-water bridges consist of ordinary culvert-type slab spans over the openings, and two types of foundations are used. For rock footings the small piers are carried 12 in. into the rock and anchored with fish bolts (Fig. 2). Where the foundations are gravel or clay a continuous slab footing is placed, and along its upstream and downstream edges under the curbs of the bridge a continuous cutoff wall is carried down in a trench 4 ft. below the footing slab (Fig. 3).

The openings are placed in the center of the structure and concrete retaining walls are carried back to a point where the level of the bridge floor intersects the natural ground surface. On rock footings the retaining walls are of gravity type and anchored to the rock with fish bolts; on gravel and clay foundations they are L-shaped with the principal width of the footing turned outward to form, if needed, a protection against scour. The top of the retaining walls forms a part of and is in continuous line with the curbing over the openings. Between these retaining walls a fill of large stone, gravel and earth is placed and moist-tamped. The fill is covered on top by a 5-in. plain concrete slab. This slab is separated from the retaining walls at the sides by tar paper, and has similar joints transversely at intervals of 30 ft.

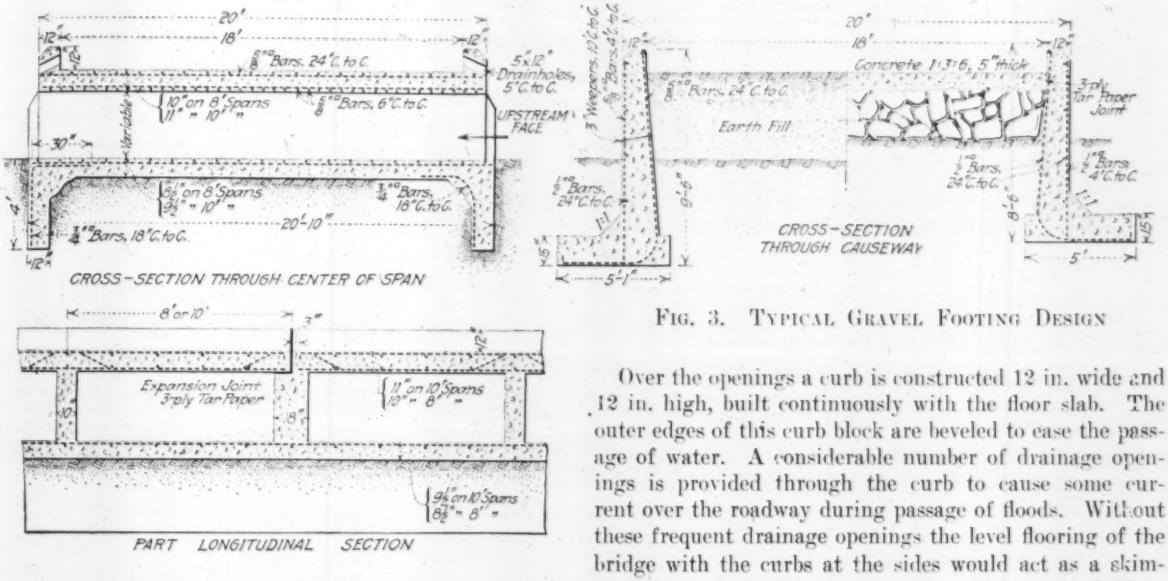


FIG. 3. TYPICAL GRAVEL FOOTING DESIGN

Over the openings a curb is constructed 12 in. wide and 12 in. high, built continuously with the floor slab. The outer edges of this curb block are beveled to ease the passage of water. A considerable number of drainage openings is provided through the curb to cause some current over the roadway during passage of floods. Without these frequent drainage openings the level flooring of the bridge with the curbs at the sides would act as a skimming basin and fill with silt. The width of the bridges is 18 ft. clear between curbs. The road surface across these bridges consists of a gravel macadam which will be tarviated. The tarvia treatment is not absolutely essential but obviates the possibility of some resurfacing after floods.

The height of the structures varies from 3 to 5 ft.

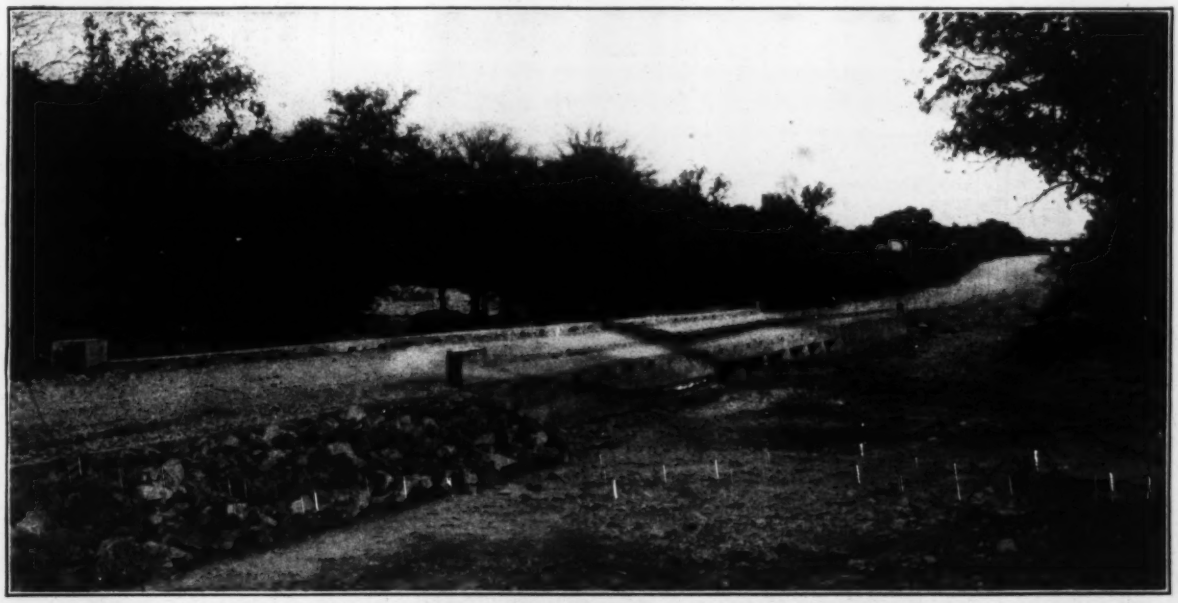


FIG. 4. LOW-WATER BRIDGE ACROSS LEON CREEK, BEXAR COUNTY, TEXAS

above the stream bed, and with the thin slab and low curb they offer little obstruction to floods. There is no rail.

DIMENSIONS AND COSTS OF LOW BRIDGES, BEXAR COUNTY, TEXAS

Name of Structure Road Stream	Openings, Ft.	Length of Approach Walls, Ft.	Total Length, Ft.	Total Contract Cost	Cost per Lineal Ft.	Cost per Sq. Ft. of Net Width	Footings
Austin—Salado	13-10x4	122	252	$5472.86	$21.70	$1.20	Shale
Seguin—Salado	5-10x2.5	85	135	2642.00	19.55	1.09	Clay
St. Hedwig—Salado	6- 8x4	20	68	2036.75	29.90	1.66	Clay
Sulphur Springs—Salado No. 1	5-10x2.5	35	85	2152.90	25.30	1.40	Clay
Sulphur Springs—Salado No. 2	4-10x2.5	15	55	1672.00	30.40	1.69	Clay
Fredericksburg—Leon No. 1	7- 8x2.5	90	146	2032.72	13.90	0.77	Rock
Fredericksburg—Leon No. 2	6- 8x2.5	92	140	2434.17	17.35	0.97	Rock
Fredericksburg—Leon No. 3	6- 8x2.5	44	92	1496.57	16.30	0.91	Rock
Fredericksburg—Leon No. 4	6- 8x2.5	62	110	2008.75	18.30	1.02	Rock
Fredericksburg—Leon No. 5	6- 8x3	122	170	3199.00	18.80	1.05	Gravel
Castroville—Leon	12-10x3.5	16	136	4063.00	29.90	1.66	Clay
Totals			1389	$29,210.72			
Averages					$21.10	$1.17	

Note: All widths 18 ft. between curbs. The higher costs are in cases where the lengths of extension walls is small compared to the length of bridge proper over the openings. Rock footings are also cheaper than footings requiring a lower footing slab.

The appended table of costs does not indicate the full economy of these structures; the cost per square foot is somewhat less than for high bridges, but it must also be remembered that the high bridges are two or even three times as long as is necessary for the low bridges.

All of the low bridges are being constructed by Thos. C. Nelson, contractor, under the designs and supervision of Bartlett & Ranney, Consulting Engineers for Bexar County, Texas.

For at least 99.5% of the time, under the conditions described, the low-water bridges will give the same service to traffic that would be effected by the usual type of high bridges and at an average investment of not over one-quarter.

New Railway Terminal at Denver, Colo.

The passenger terminals of the railways entering Denver, Colo., have been inadequate for traffic conditions for some years, and plans have now been adopted for enlarging the terminals and remodeling the union station. The present terminals were built by the Union Depot & Railway Co. in 1880; they were enlarged in 1894, and in that year the station building was burned but was rebuilt practically on the original plans.

The Denver Union Terminal Ry. Co. was organized in 1912 to take over the holdings of the old company, and to purchase additional property and increase the facilities. The six trunk lines which enter the city hold equal interests in this company, and an engineers' committee was formed consisting of the chief engineers of these roads, as follows: F. C. Cowan (Chairman), Colorado & Southern Ry.; C. F. W. Felt, A., T. & S. F. Ry.; T. E. Calvert, C., B. & Q. R.R.; C. A. Morse, C., R. I. & P. Ry.; J. G. Gwyn, D. & R. G. R.R., and R. L. Huntley, U. P. R.R. The committee employed C. C. Post (Assistant Engineer, U. P. R.R.) to prepare the plans for the new terminal, and approved these in July, 1913. It also appointed Gove & Walsh, of Denver, as architects for the building. The total cost of the improvements, including the purchase of new property (but not the purchase of property of the old company), is estimated at $2,280,000.

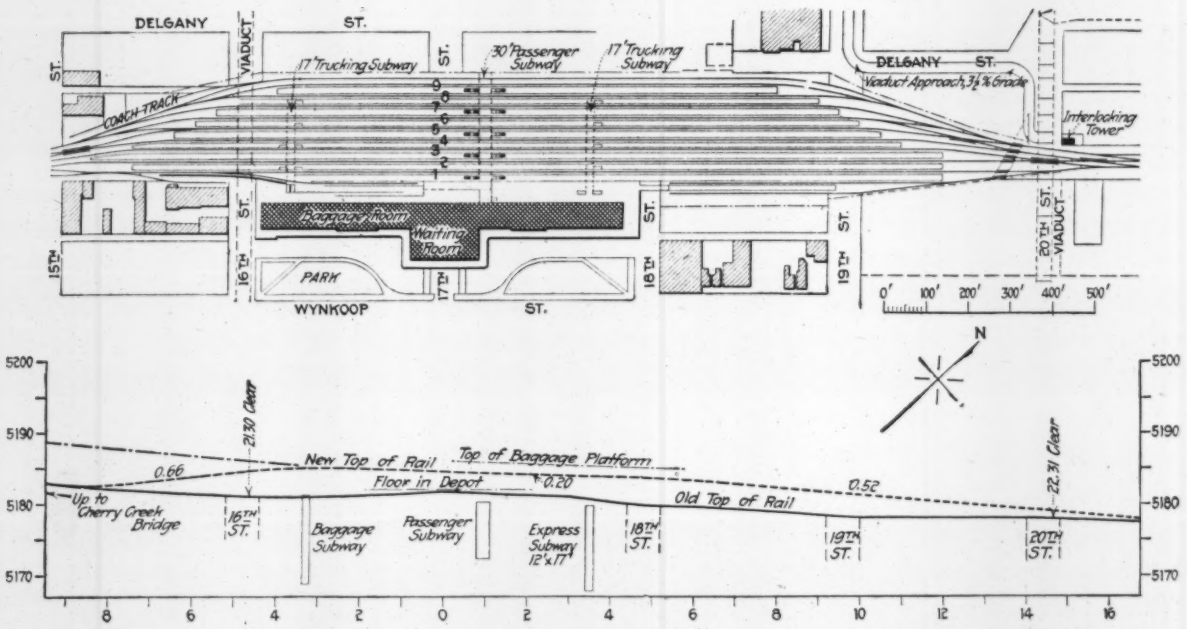


FIG. 1. PLAN AND PROFILE OF THE NEW UNION STATION AT DENVER, COLO.

A general plan of the new terminal is shown in Fig. 1. The yard will be raised 5 ft. above its present level, and will have a transverse slope of 1% from the building in order to provide drainage. This raising of the track level was necessary in order to get clearance for a passenger subway having its floor above the water level of the Platte River, which runs near the station and is subject to floods. The station is of the through type, with the building at one side. The track plan provides for nine through tracks having an average length of 2400 ft., and outside of these

will be a track for freight traffic and switch-engine movements. The four outer passenger tracks are of mixed gage (4 ft. 8½ in. and 3 ft.), to accommodate the narrow-gage lines. All switches and signals will be interlocked, and will be operated from two towers, one at each end of the yard.

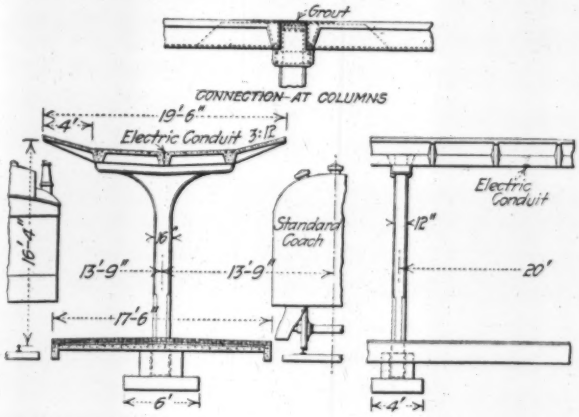


FIG. 2. CONCRETE PLATFORM SHELTERS OF UNIT CONSTRUCTION, FOR THE DENVER UNION STATION

Passengers going to the trains pass through the ticket gates and descend a 12-ft. incline on a grade of 1 in 10 to a subway 30 ft. wide, from which stairs lead to the several platforms. From the end of this subway an incline extends under the building, ascending to the street level, so that passengers from the trains can go directly to the street. This arrangement is shown in Fig. 3. The floor of the subway is 8 ft. below that of the building and concourse, and 13 ft. below the passenger platforms.

The present station building will be retained, but enlarged and remodeled. The central portion will be pulled down and rebuilt as a fireproof steel and tile structure 165x146 ft. It will be faced with granite at the base, and terra cotta above. This portion of the station will include the main entrance, the waiting room (100x100 ft.) and passenger facilities. The two wings are each 64x180 ft. One will contain the dining and lunch rooms and the express and mail offices. The other will be occupied almost entirely by the baggage room. The contract for the remodeling of the building has been awarded to Stocker & Fraser, of Denver.

The construction of the new terminal will necessitate the closing of several streets. This will include 19th St., making necessary a connection between this street and the 20th St. viaduct. This approach will be of steel construction with a 20-ft. roadway on a grade of 3½%. The 16th St. viaduct will have to be raised 5 ft. for a distance of 750 ft. in order to give the necessary clearance for the tracks at their new elevation.

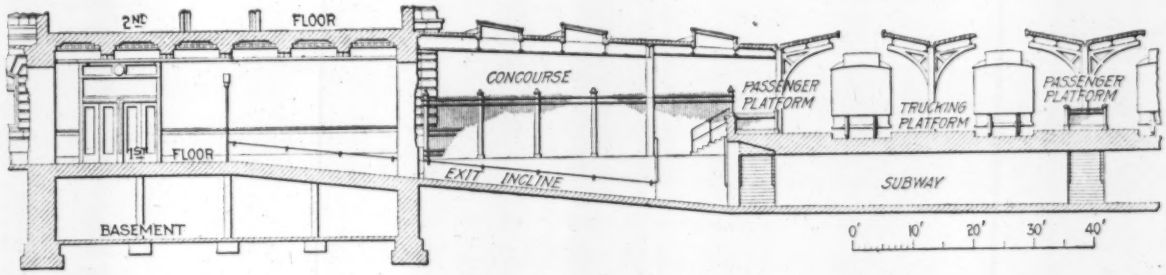


FIG. 3. CROSS-SECTION OF NEW STATION AT DENVER, COLO.
(This shows the concourse, platforms and subway, with exit incline leading directly to the street)

The track and platform arrangement is unusual, the tracks being arranged singly instead of in pairs, and alternate platforms being for passengers and for trucking service, thus keeping the passenger platforms entirely free from truck movements. The platforms are 1200 to 2050 ft. long and those for trucking are nearly the same width as the others, the spacing of tracks being alternately 27½ ft. c. to c. (over the passenger platforms) and 24 ft. c. to c. (over the trucking platforms). The passenger platforms will have shelter roofs of the butterfly type. These will be built of separate concrete parts or units, erected in the same way as steel or wood members. The design is shown in Fig. 2; these shelters will be built by the Unit-Bilt Construction Co., of St. Louis, Mo.

At one end of the station is a subway for express and mail trucking, and at the other end is a similar subway for baggage. Electric motor trucks will be used. At one end is a single stub track for baggage cars and at the other end a similar track for mail and express cars. These have high platforms reached by ramps.

The concourse, between the station building and the tracks, is 40 to 50 ft. wide. It is level with the main floor of the building, and 4 ft. below the platform level, and is separated from the first train platform by a fence.

A Sanitary Survey of Vincennes, Ind., made by the Indiana State Board of Health, was described by John Diggs, State Water Chemist, in a recent paper before the Indiana Sanitary and Water Supply Association. The work was carried on for approximately four months with an organization of five men. Vincennes is one of the oldest towns in Indiana and at present has a population of approximately 17,000. During the investigation every private well was given chemical and bacteriological examination and the sanitary conditions surrounding each house were studied and tabulated. There are in use approximately 3000 wells, a larger proportion than are in use in any other city in the state, while the city's water-supply is a very satisfactory filtered water from the Wabash River. There are also in use 3229 privy vaults, in spite of the fact that the city has installed recently the best sewerage system in Indiana. A total of 3989 private residences were surveyed, and of the wells examined, 722 were found to be polluted and condemned; these were principally found in the older section of the city. Privy vaults to the number of 611 were condemned and 187 cesspools were ordered to be eliminated. In spite of the fact that the city is situated on a pervious gravel stratum there were found to be quite a large proportion of the wells—some in use as long as fifty years—producing a water of good analytical character and quite suitable for a public water-supply.

Bituminized Earth Paving

A method of making a bituminous earth pavement has been in use for about three years at Iola, Kan. The earth obtained along the road or street, or from any convenient place, is delivered to a portable plant on the ground. In this it is first heated, pulverized and screened. The dust is then raised to a mixing hopper where hot asphalt is admitted in the form of a fine spray, so that the dry dust will absorb it. The quantity and character of the asphalt vary with the character of the earth used.

The mixture is dumped from the hopper into wagons and distributed upon the roadway, where it is spread to a thickness of about 1½ in. When cool, it is rolled with a 5-ton roller. The process is repeated until a depth of about 3 in. has been obtained.

Practically any kind of material that will absorb asphalt can be used. Hard and nonabsorbent materials are not suitable, and a sandy loam having a large proportion of coarse, flinty sand would be less suitable than a loam without sand. It is stated that with the absence of hard material or aggregate no expansion joints are necessary, and there is no tendency to crack or disintegrate. The wearing surface is waterproof, but care must be taken to keep the subgrade well drained.

The first paving at Iola was on a single block, in October, 1911. Since then 26 blocks of pavement have been laid, the foundation in all cases being the natural soil, well rolled and compacted. C. E. Stebbins, Commissioner of Streets, has reported favorably on this paving. The process and manufacturing plant are controlled by the Bituminized Road Co., of Kansas City, Mo. The cost is said to be from $1.10 to $1.25 per sq.yd. of 3-in. paving.

Unused Irrigation Canals

By F. H. Newell*

A striking feature of the latest report of the State Engineer of Nebraska† is the summing up of the condition of irrigation in the state. It is shown (page 52) that of all the canals built within the state 53% were in operation during 1914. In other words, only a little over one-half of the works built in previous years have been put to beneficial use. Many of these unused or abandoned canals were of small cost, but others represent very large investments. When we come to mileage the showing is a little better, as 60% of the total mileage constructed was in operation; but the acreage actually cultivated was less, being approximately 50% of the land which could have been supplied by the canals which did operate, and, of course, only a very small portion of the total acreage which might have been supplied from the canals built at one time or another.

The causes of this condition are attributed to lack of water, or to put it in another way, many of the canals were built for an acreage larger than could be supplied by the ordinary flow. The failures thus go back to over-enthusiasm, to speculation, and really to poor engineering or neglect of engineering advice. Somewhere along the line has been carelessness or inexcusable ignorance, as for many years the limitations of water-supply have been fairly well known or could have been predicted.

The investment in canals and lands not utilized, and the corresponding losses, run into millions of dollars. The totals will probably never be known, but the effect here, as elsewhere throughout the West, has been to cause irrigation to fall into disrepute and to hold back the proper growth of the country and the use of its natural resources. The engineering profession as a whole, as well as investors, must lose directly and indirectly. The lesson so dearly learned should not be lightly disregarded. There is a tendency to forget these disagreeable facts, but it is the duty of the engineering profession to keep them in mind and avoid similar dangers in the revival which it is hoped will soon come in work of this character.

*Late Director, U. S. Reclamation Service, Washington, D. C.

†Tenth Biennial Report of the State Board of Irrigation, Highways and Drainage to the Governor of Nebraska. By Donald D. Price, State Engineer, Lincoln, Neb.

Difficulties of Drainage-Ditch Contractors

Some of the difficulties (engineering, legal and financial) encountered by contractors for drainage-ditch excavation were outlined at the meeting of the Iowa State Drainage Association, at Webster City, Feb. 25-26, in a paper by H. B. Whitney, contracting engineer, of Des Moines, Iowa.

In the form of contract very generally employed, a clause provides that the contractor "shall keep the ditch in good condition and repair at his own expense until it is finally accepted." Another clause provides that he is to "sustain all damages from the action of the elements." In some extreme cases it has been claimed that the contractor must deliver the ditch true to grade at the time of its acceptance, in spite of the fact that silting will commence as soon as a part of the channel is completed, and that silt will be brought in by all tributary streams.

On behalf of the contractor, it is claimed that he has a right to assume that the engineer has planned the ditch to provide for natural silting. If the contractor should find it necessary to excavate deeper to allow for silting, he would not be allowed pay for this excess excavation. Even if the work should be improperly planned, it is not the part of the contractor to make it good. He undertakes to do certain work in accordance with plans and specifications on which his bid is based, and he is not liable if the work should then prove unsatisfactory from faulty design.

River-straightening jobs for drainage improvement are sometimes a source of dispute in this connection. In such work it is usual to design the ditch of smaller capacity than would be required to carry flood waters, it being expected that the channel will scour and widen to the required dimensions. It seems then unfair for the supervisors to hold the contractor liable for caving banks, when the original intent was that they should cave, and he has completed the work as called for by the contract and specifications.

Another cause of trouble is where the width of right-of-way is specified arbitrarily, without regard to depth of channel or other conditions. In one case a width of 100 ft. was specified where the bottom width was 20 ft. with ½:1 slopes and a depth of 16 to 22 ft., while a berm of 8 ft. was required on each side of the cut. The Iowa law does not allow the contractor to place material

outside of the right-of-way line, and it may be a risky matter to pile such a mass of material so close to the edge of the ditch. It is especially serious to the contractor if this should cause the banks to cave, compelling him to rehandle the material to "maintain" a channel which he had completed according to requirements.

In a case of this kind where the contractor had to take out an excess of material due to caving slopes, and had spread this outside of the right-of-way (the width of which was ample for the normal cut), the court sustained the landowner in a claim for damages. Where material from wet spoilbanks has simply flowed outside of the line, the courts have held that the landowner has no ground for damages, as he has lost no land and can in time cultivate on the new soil.

The trouble seems to be largely in the lack of coöperation between the several parties interested: the supervisors, the attorney, the engineer and the contractor. Trouble for the contractor is very apt to develop in cases where the supervisors are not in accord with the engineer, and are not inclined to accept his decision in disputes, although the contract makes his decision final, and binding on both parties.

The board of supervisors is elective, and the engineer is appointed by the board. If the work extends over three or four years, the board may have changed by the time the work is completed and the new board may refuse to abide by the engineer's decision, or to pay for the work, and the contractor's only recourse then is litigation.

Under the present system, the county board of supervisors acts for the drainage district, but the county is not liable for the acts of its commissioners on drainage matters. The courts may order the board to act, but cannot say how it shall act. The drainage district has no entity in court and cannot be sued. At the meeting at which Mr. Whitney's paper was read, a resolution was passed by the Iowa State Drainage Association recommending that the laws should be so changed as to make drainage organizations independent of the county boards, and to put the management of a drainage district in the hands of a board of three commissioners elected from among the land owners of the district.

Comparative Costs of Brick and Concrete Roads in Illinois*

By H. E. Bilger†

From the actual cost records of constructing about 75 different sections of state highway in Illinois during the last year it is certain that the itemized estimates were reasonably well balanced. By excluding all rough grading, drainage structures and the like, and prorating the estimated cost of the pavement proper to the contractor's bid, it is possible to get not only relative figures, but almost absolute prices on the different concrete and brick pavements proper.

From the experience gained on these 75 contracts, it would appear that where the haul does not exceed 2 mi., the brick pavement proper has been built at an average cost to the taxpayers of $2 per sq.yd. and the concrete pavement proper at a cost of $1.20 per sq.yd. The greatest variation from these average figures is not large, and they may be taken as substantially correct, save that with slight changes in the specifications the price of the brick pavement proper, including the concrete curb, could have been reduced to $1.90. Having those two figures in mind, $1.90 for brick and $1.20 for concrete, it is interesting to consider some of the economic features of these two types of pavement.

If we assume for road improvement the issuance of 5% 20-yr. serial bonds, payable annually, the interest charges on the value of 1 sq.yd. of brick pavement would be $1.

Reliable data on the maintenance and repair expenses for brick roads in rural territory are not available. From what are available, however, and from the experience of small cities with this type of pavement, it would appear that a charge of 1c. per sq.yd. per year would be sufficient to cover all maintenance and repair on a brick road in rural territory for the first 25 years.

These three costs—namely, first cost, interest and maintenance—total $3.15 per sq.yd. as the actual cost to the taxpayers of a brick road at the end of 25 yr. Maintenance charges on the shoulders and right-of-way are excluded from this consideration, inasmuch as they apply equally to whatever type of pavement is adopted.

The corresponding interest charges on the cost of 1 sq.yd. of concrete pavement would amount to 63c. Cost data on the maintenance and repair of concrete roads are even more meager than on brick, and estimates as to the probable life of the road are still more at variance. One would be presumptuous, indeed, to assume that under mixed traffic conditions the probable life of a concrete road would be as long as that of a brick road. However, from the experience with the concrete roads that have been constructed in recent years under the supervision of the Illinois State Highway Department, and from my own personal observations elsewhere, there is every indication that the concrete road is amply capable of rendering a service fully commensurate with its cost of construction.

It is quite probable that after a service of nearly 15 yr. under mixed traffic, the road would economically admit of resurfacing. From present knowledge it would appear that the most practicable low-first-cost resurfacing for a concrete road, unevenly worn, is one of bituminous concrete some 3 in. in average thickness. It is quite likely that this surfacing would incur an expenditure of as much as 75c. per sq.yd. To meet this expense, if we issue 5-yr. serial bonds, payable annually, computing interest as before, and estimating maintenance charges at 2c. per sq.yd. per year throughout the 25 yr., we have a total cost of a concrete, bituminous-top road at the end of 25 yr. of $3.19 per sq.yd.

It is hardly probable that the maintenance and repair charges under the conditions in question could fall below 2c. per sq.yd.; but it goes without saying that there are elements of uncertainty in the foregoing consideration of upkeep in both types of pavement, as well as in probable life. Moreover, the other estimates of cost will be somewhat modified by local conditions.

Omitting topographic requirements it can be stated generally that the considerations in order of weight for the adoption of these types of pavement are, first, intrinsic merit; second, a final cost to the taxpayers.

*From a paper read before the Illinois Society of Engineers and Surveyors.

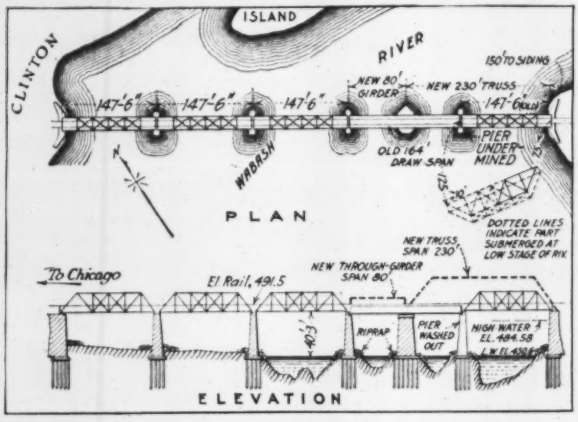
†Road Engineer, Illinois State Highway Department, Springfield, Ill.

Field and Office

How a Washed-Out Bridge-Span Was Pulled Out of a River

During the spring floods of 1913 the water in the Wabash River at Clinton, Ind., rose 5.2 ft. above previous records. The C. & E. I. R.R. bridge at this point consisted of four 147½-ft. through-truss spans and one 164-ft. deck plate-girder draw-span, three of the trusses being located west of the draw and one east, as shown in the accompanying drawing. The pier supporting the east end of the draw was undermined, allowing the east fixed span to fall into the river, while the draw-span remained in place cantilevered over the pivot pier.

A temporary pile bridge was built, using 75-ft. piles driven in 44 ft. of swiftly running water to a penetration



WABASH RIVER BRIDGE OF THE CHICAGO & EASTERN ILLINOIS R.R. AT CLINTON, IND., SHOWING THE RECONSTRUCTION OF PORTION DAMAGED BY THE FLOOD OF 1913

of 8 ft. In January, 1915, the temporary work and draw-span were replaced by a 230-ft. pin-connected truss span and an 80-ft. through-girder span. The west end of the new 230-ft. truss is supported by the pivot-pier, as shown.

No attempt was made to recover the truss from the river until after the new steel was in place, as the temporary structure was not of sufficient strength to stand the pull from derrick cars. It was not until June, 1914, that the water was low enough to try to remove the span from the river.

The span had landed on its side, with the top chord downstream, the west end about 125 ft. and the east end about 75 ft. from the center line of the bridge. When the river registered 2 ft. 7 in. above low-water mark, the west end was in 25 ft. of water and about half of the east end of the upper truss was visible. It was found that considerable sand and débris had collected around the floor. It was decided to recover the span for scrap and to remove the obstruction from the stream.

The plant used consisted of one 100-ton wrecking crane, one 50-ton self-propelling derrick car, and a rapid-unloader machine. The 100-ton derrick was stationed over the east abutment. The 50-ton derrick was stationed on the new truss about 75 ft. from the east abutment, its drum operating four-part tackles of ⅝-in. cable attached to snatch-blocks secured to the top chord of the new truss. The unloader was placed on a temporary side track 150 ft. east of the bridge, and its cable was attached either directly to the span in the river or by being led through a block from the first panel point of the new truss-span.

The first pull was made on the east batter-post of the upper truss. The hitch was made with 1⅜-in. chains, but these broke under heavy pull. After this all hitches were made with 1½-in. cable, using several cable clamps on each loose end, and no trouble or delay was experienced with hitches breaking. The batter-post was easily pulled away from the truss by the combined lifting power of the three machines. The next hitch was made to the east end of the top chord of the upper truss, the two derricks pulling vertically and the unloader pulling horizontally.

All connections above water had been burned loose by the oxweld process. The west batter-post became disconnected at the lower end, permitting the chord and post to move east about 50 ft. and bringing it above water so that the web members could be burned off. The top chord and the east batter post of the lower truss were pulled out in the same manner. The end stringers were pulled loose from the first floor-beam by the 100-ton derrick.

The next hitch was made to the first floor-beam, the end of which projected about 18 in. above the water. With three machines lifting vertically to their full capacity, it was found that the member could be raised only 6 or 8 in. after four attempts. The floor-beam was then burned from the bottom chord of the upper truss and pulled from the track stringers in the second panel and the hip hanger of the lower truss. The track stringers in the second panel were removed, after which the east end of the bottom chord of the lower truss was lifted out of the water and burned off at the second panel-point. All of the iron within reach without the use of a diver was broken off with the small derrick.

All of the span left remaining in the river was 6½ ft. below the surface of the water when the gage registered 2 ft. 7 in. above low-water. This is ample to allow for navigation. The cost of recovering about 40 tons of iron was about $400. The work was done under the direction of L. C. Hartley, Chief Engineer, Chicago & Eastern Illinois R.R.; A. S. Markley, Master Carpenter, was in direct charge.

Dumping-Bridge for Building an Embankment in Tidal Water

Part of the extensive harbor work now going on at Halifax, N. S., is a rock-fill breakwater in 50-ft. maximum depth of water extending 1500 ft. out from shore. This is being constructed by Cook Construction Co. & Wheaton Bros. The same firm has a contract for taking

out two very large rock cuts in the line of the new railway approach to the new wharf and pier district which the Government is building. The material taken out of these cuts is in large part used for building the breakwater; the rest of it is being deposited as fill in building out the shore line to the new shore front bulkhead or sea wall. The total amount of material in the cut is 2½ million cubic yards, practically all of it rock.

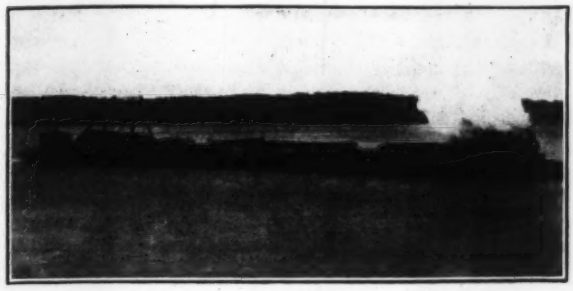


FIG. 1. HALIFAX BREAKWATER; DUMPING-BRIDGE AT END

About 250,000 cu.yd. is in the breakwater, distributed as follows: Core, fine material, 147,000; sea slope, large material, 56,000; harbor slope, 25,000; paving, stone blocks, 15,000.

The depositing of material for the breakwater is being done by a very interesting method devised by the contractors. A floating apron is used as a dumping-bridge, in spite of tide effects; water ballast keeps the apron scow at constant level. The view of the work, Fig. 1, does not show the arrangement clearly enough, and it is therefore sketched out in Fig. 2. A plate-girder bridge 40 ft. long is mounted at its forward end on a barge 40x80 ft. and its rear end rests on four or five cross-ties laid on the outer corner of the embankment. The spoil, brought along in 16-yd. dump cars, is dumped directly from this bridge. Three or four cars at the head of the train are run on the bridge, dumped and returned. The track is continued across the scow as a tail-track.

The tidal rise is about 6 ft. To keep the bridge level, water-ballast tanks are provided in the scow; these are pumped full as the tide rises, and pumped out on the fall of the tide, keeping the dumping-bridge level with the embankment.

When the embankment has been built up high enough (4 ft. above mean water) in the space spanned by the

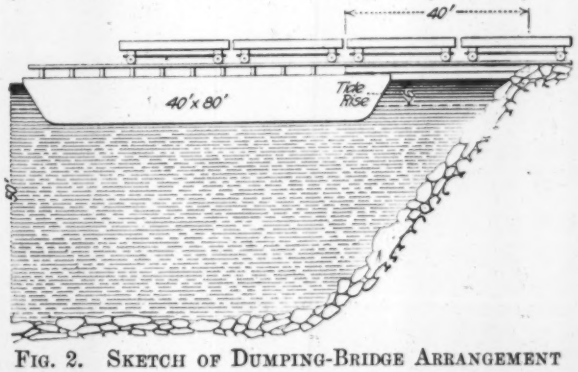


FIG. 2. SKETCH OF DUMPING-BRIDGE ARRANGEMENT

bridge, the scow and bridge are simply hauled forward until the bridge comes to a new bearing on the new outer point of the embankment and the process is continued. About 1300 ft. of the breakwater has been completed.

Contractor's Methods and Plant at the Kennerdell Tunnel of the Pennsylvania R.R.

Change in line on the Allegheny Valley division of the Pennsylvania R.R. between Buffalo and Pittsburgh involved the construction of three tunnels: the most northerly at Kennerdell, Penn., 3500 ft. long; the next at Wood Hill, 2680 ft.; and the third at East Brady, 2405 ft. The tunnels are generally lined with concrete to a point 7 ft. above spring line, from where one ring of vitrified brick is laid and backed with concrete placed by compressed air. This article describes the contractor's plant and in general the method of building the Kennerdell tunnel.

The rock, a shaly sandstone in horizontal layers, presented little difficulty. It broke evenly and required little packing back of the lagging. The contract for the Kennerdell tunnel was let two years ago. The tunnel was holed through on Oct. 10, 1914, and the timbering met on Jan. 31, 1915. Bench excavation was completed Feb. 24. Much of the timber was cut on railway property in the vicinity. Stone for the portals was quarried on the job.

TWO INTERESTING OPERATIONS

SINGLE BENCH—The original method of driving the tunnel was the top-heading and two-bench, but the usual sub-bench work was later eliminated by using the extension drills described in ENGINEERING NEWS of Feb. 18, p. 350. These permit of drilling 18-ft. bench holes in 10 ft. of headroom.

TIMBER ERECTION—The method of erecting the timbering was also interesting and was described in our issue of March 18. The first ring was erected in the usual manner, but the segments of the succeeding rings were placed with surprising facility by means of metal hangers or stirrups hung from the blocks of the completed ring, carrying cantilever braces which supported the segments of the ring being erected. This did away with the cumbersome method of placing the blocks by hand and holding them thus until temporarily propped by sticks until the keypiece was placed.

DRIVING THE TUNNEL

In driving the heading, 24 holes were drilled; 6 cut, 8 relief, and 10 side rounds. To each lineal foot, 5 cu.yd. were removed. The heading was enlarged by two shots which cleared the material from the corners, allowing the wallplates to be set. The enlargement work was carried on 200 ft. ahead of the bench work, so that neither operation interfered with the other. The drills used were a new type when the work was started—Ingersoll-Rand C-110. For enlarging the heading, Jackhamers were used. Both Sullivan and Ingersoll-Rand drills were used on the bench. Blasting was done with 40% Forcite powder, which gave out no noxious gases, allowing work to proceed immediately after shooting.

The wallplate sections were 16 ft. long and were set 6½ ft. above spring line. The rings of timbering, of 19-ft. radius, were spaced 3 ft. 8 in. apart. Each ring consisted of seven segments of 12x12-in. timber. Close lagging of poles was used.

Heading muck was conveyed in end dumpcars to the edge of the bench, where it was dropped over onto the tun-

nel floor. Here it was loaded onto dumpcars by a steam shovel which also handled the bench excavation. On the north end the muck trains were hauled by two 18-ton and one 10-ton dinkey engines; on the south end five 10-ton dinkeys were used.

A 40-ton Marion steam shovel excavated on the north end, a 40-ton Bucyrus on the south. In addition to these a 70-ton shovel excavated the south approach. Total excavation per lineal foot of tunnel amounted to 35 cu.yd. The muck was used for filling.

Lining

The side forms for the concrete lining were wood and framed on the job. For the arch, steel centering was used. The arch is faced by a ring of vitrified brick with concrete behind. The masonry averaged 5 cu.yd. per lin.ft. all the way through.

Batch mixers were installed at first, but these were soon replaced by the pneumatic system of mixing and conveying, and much better time was made on the concreting.

The sand was obtained from the Pittsburgh Plate Glass Co.; river gravel was obtained in the vicinity of Pittsburgh. The concreting materials were delivered to bins at the north portal. Under the bins was the pneumatic mixer which blew the concrete to the forms. When the work had advanced inward too far to operate the mixer economically, a second mixer was installed under bins at a point 600 ft. inside the tunnel, and the dry materials were fed to these second bins to be used by the second mixer. These interior bins held from 70 to 80 cu.yd. each.

The side forms were erected at least 60 ft. ahead of the arch work. When both side and arch operations were progressing simultaneously, two mixers were used inside the tunnel—one for the side forms, the other for the arch forms, so that each operation could be carried on independently.

Batches of ½ yd. were mixed and placed every 1½ min. A shovel and 8 drills were taking air at the same time, so that it was found that the most efficient distance to blow, with the pressure available, was 200 ft.; 400 ft. was the maximum for good results.

Power Plant

The power house contained five 100-hp. return-tubular boilers and two compressors with a total capacity of 3600 cu.ft. of free air per min. A 6-in. air line was run one mile over the hill. There was provision, also, for illuminating the tunnel by electricity. Current was transmitted at 2200 volts, and stepped down to 110 volts for the 800 lamps supplied. The transmission was carried over the hill on poles.

Personnel

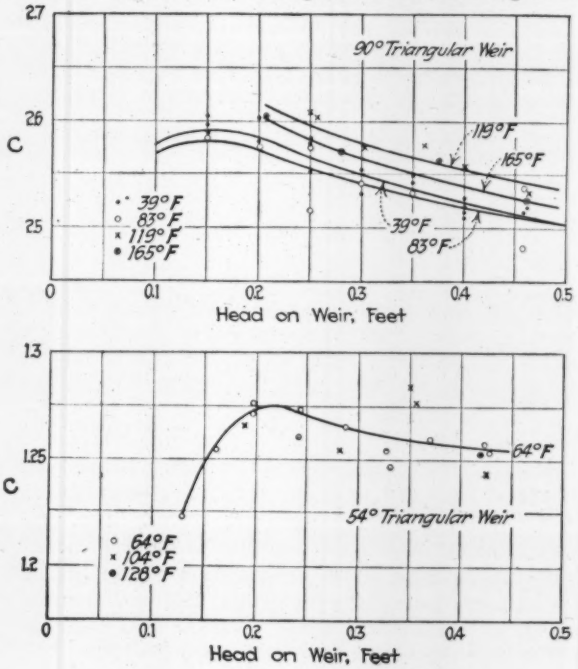
During the working season the contractor, John A. Kelly Co., maintained two organizations, each with two 10-hr. shifts. There was a total of 250 men, one organization on each end. The work was done under the direction of A. C. Shand, Chief Engineer of the Pennsylvania R.R., George Nauman, Assistant Engineer, George Patton, Resident Engineer. John A. Kelly, Jr., supervised the work for the contractor; Richard McGuckin is heading superintendent. It is estimated that the work will be completed in six months.

Tests of the Effect of Temperature on Weir Coefficients

By F. G. Switzer*

The writer recently had opportunity to study the effect of temperature on the measurement of water by weirs. Results of the tests are given in the accompanying diagram. The wide use of this method of measuring boiler feed water, etc., prompted the investigation.

The apparatus used consists of a weir-calibrating set-up which is designed for capacities up to 1 cu.ft. per sec. In these experiments, live steam was introduced into the water above the weir in such a manner as to get uniform temperature at the weir. The water was measured by weighing in a large tank supported on two edges, one on the floor, the other resting on a scale; the edges are



Effect of Temperature on Weirs

fixed so that the weight of the water collected is double that shown by the scale. A chute diverts the water into the tank. In order to prevent loss by evaporation, both weir box and weighing tank were covered with canvas. A hook gage reading to thousandths of a foot was used to measure the head on the weir. A 90° triangular-notch and a 54° triangular-notch weir were tested. The former consisted of a $\frac{1}{16}$-in. brass plate 12x18-in.; the edges of the downstream side were beveled off, giving a knife edge. The second weir was a standard notch of the Harrison Safety Boiler Works.

The results were plotted in the accompanying curves on a very large scale so that what may seem a large error is in reality a small percentage. No point is more than 2% from a mean and the great majority of points are within 1% of a mean. The results of these experiments give a negative rather than a positive conclusion. It is probable that the effect of water temperature is inappreciable compared with other factors present. It is of interest to note earlier studies (Phil. Mag., Oct., 1878, p. 287; J. C. Mair, Proc. Inst. C. E., Vol. LXXIIV), in

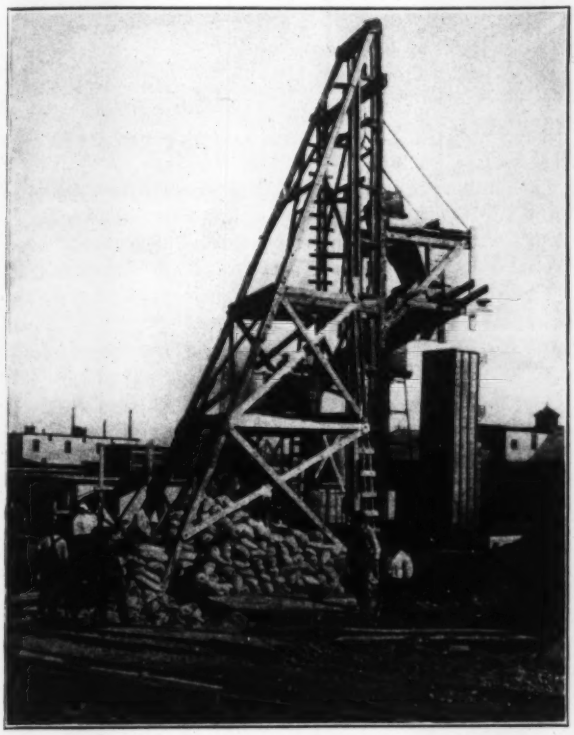
*Crocker-Wheeler Co., Ampere, N. J.

which it is concluded that, for a sharp-edged *orifice*, temperature of the water has negligible effect.

The writer is indebted to Prof. R. L. Daugherty, in charge of hydraulics at Sibley College, Cornell University, for assistance in obtaining these data.

A Movable Concrete Tower; Home-Made Skip

The Stone & Webster Engineering Corporation recently built a coal-gas plant for the Fall River Gas Works Co. There are six brick buildings with concrete foundations, floors and roofs, calling for small quantities of concrete at widely separated points during various stages of the work. To build a tower at each building and leave it equipped while work was going on in other places was impossible. To pour by hand would have been too expensive. A plan was devised, therefore, for a movable tower.



STONE & WEBSTER'S TOWER ON SKIDS, FALL RIVER

This tower was 40 ft. high, in the form of an A-frame resting on three 10x10-in. skids about 20 ft. long, giving a very solid base, which was weighted down with a half-yard steam-driven mixer.

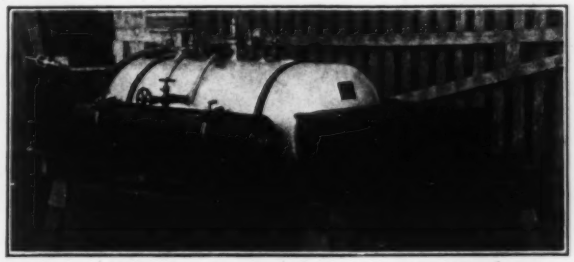
In place of the usual four posts of a concrete tower, two posts were used, built up from stock lengths of 2x10, 3x4 and 2x6, in such a manner as to leave a 4x3-in. groove on the inside, in which the skip bucket traveled.

It was impossible to get a ½-yd. skip bucket locally and to hasten matters a bucket of the proper size was assembled in the field. A rectangular frame 5x4 ft. of 2½-in. pipe was made which fitted into the groove of the tower posts. An ordinary ½-yd. derrick bucket was stripped of its bail and mounted in this rectangular frame, pivoting on a 3-in. pipe sleeve around the lower member of the frame. The top of the bucket was guided by two rollers running on a track which curved over at the top so as to dump the bucket into a hopper which delivered into gravity chutes leading to various parts of the work, sometimes at a distance of over 100 ft.

As an economic proposition, the device proved satisfactory under the conditions at Fall River.—L. E. PALMER, Boston, Mass.

A Mine Fire-Engine

A portable apparatus for directing by means of air pressure a jet of water or fire-extinguishing chemical on fires occurring in mines has just been placed on the market by James Boyd & Bro., Philadelphia, Penn. The apparatus is mounted on a steel frame which can be placed on a mine car or other vehicle. It consists of a chemical tank and two separate cylinders containing compressed air at 1000 lb. per sq.in., which are connected to the chemical tank. By opening a valve the air enters the chemical tank (through an automatic regulator or pressure-reducing valve which reduces the pressure to a determined amount) and forces the water or chemical solution out through the nozzle.



COMPRESSED-AIR CHEMICAL FIRE-ENGINE

Empty air-cylinders can be recharged by means of a compact air compressor operated by a 3-hp. motor, which is furnished with the outfit. A gage recessed in the end of each air cylinder shows the pressure available at all times. An automatic pressure-relief valve makes excess pressure in the chemical tank impossible.

For wetting-down purposes a perforated pipe is placed over the top of the chemical tank. With this arrangement the mine haulageways and other dry and dusty places can be sprayed with a dust-allaying solution.

Maintenance of Macadam and Gravel Roads

Many engineers have not had opportunities to accumulate extensive experience in the maintenance of macadam and gravel roads, so that brief specific answers to a few of the most pressing problems by highway engineers of experience is welcome, although the subject itself is somewhat trite. Some of the following questions and answers* refer more particularly to Central West conditions.

What should be done with a newly built water-bound macadam road that shows signs of raveling in spots?—Cover spots lightly with a good bonding gravel or stone screenings. A very light application of clay will often stop the raveling.

How may macadam roads adjacent to earth roads be protected?—Dump cinders or loose stone on the earth roads for a few hundred feet adjacent to the macadam road.

What should be done with a gravel or macadam road that is badly rutted?—Loosen the rutted surface with a scarifier, add a little new material and reroll.

*From the February, 1915, issue of "Illinois Highways."

What should be done with a road that shows signs of sinking at places?—Put in underdrains.

What is a desirable thickness for ordinary gravel or macadam roads?—Ten or twelve inches, measured loose, if road is well drained.

What is the best scheme for keeping down dust on gravel and macadam roads?—Remove all dust from the road, then apply a hot asphaltic oil or tar and then sand the surface lightly.

Can oil or tar be applied cold to the surface of a road?—Yes, the lighter grades. Such treatments are suitable for laying the dust.

Can oil or tar be applied to the road by means of the ordinary street-sprinkling wagon?—Yes, the lighter grades that need not be heated before applying. It is better to apply all bituminous material by means of a specially prepared distributing wagon.

What grade of oil should be used for laying the dust on earth roads?—The very best asphaltic oil that can be applied without heating is the cheapest. It will contain from 30 to 40% asphaltic residue. Oils containing from 50 to 70% asphaltic residue will be more lasting but will require heating before applying.

What is a desirable crown for a 12-ft. bituminous macadam road? A water-bound macadam or gravel road?—A 12-ft. bituminous macadam road about 3 in., and a 12-ft. gravel or water-bound macadam road about 4½ in.

Street Illuminating Arches, Portland, Ore.

A distinctive system of permament street illumination using steel arches was erected a few months ago along Third St., Portland, Ore., extending 10 blocks from Yamhill to Burnside St. At each street crossing a pair of intersecting arches was built, with concrete encasement around the vertical ends of the arches (Fig. 1). Each pair of arches carries ninety-six 40-watt lamps on the soffit, two clusters at the top of each column, and a 750-watt nitrogen lamp at the crown.

FIG. 1. ILLUMINATION ARCHES, PORTLAND, ORE.

Each arch is of box section 12x18 in., of four 2½x2½x⅜-in. angles latticed. It was built in four sections, field-riveted at crown and quarter-points. The arches were erected by derrick-trucks (Fig. 2) built for the work.

The concrete casing of the vertical portions or columns was rubbed smooth after the mold was stripped off, and painted a light gray, the same color as the exposed steelwork.

The system was designed by the Northwestern Electric Co., Portland, which furnishes the current. The erection of the steelwork as well as the installation of wiring and lighting fixtures was executed by W. A. Kraner & Co., Portland.—L. R. W. ALLISON.

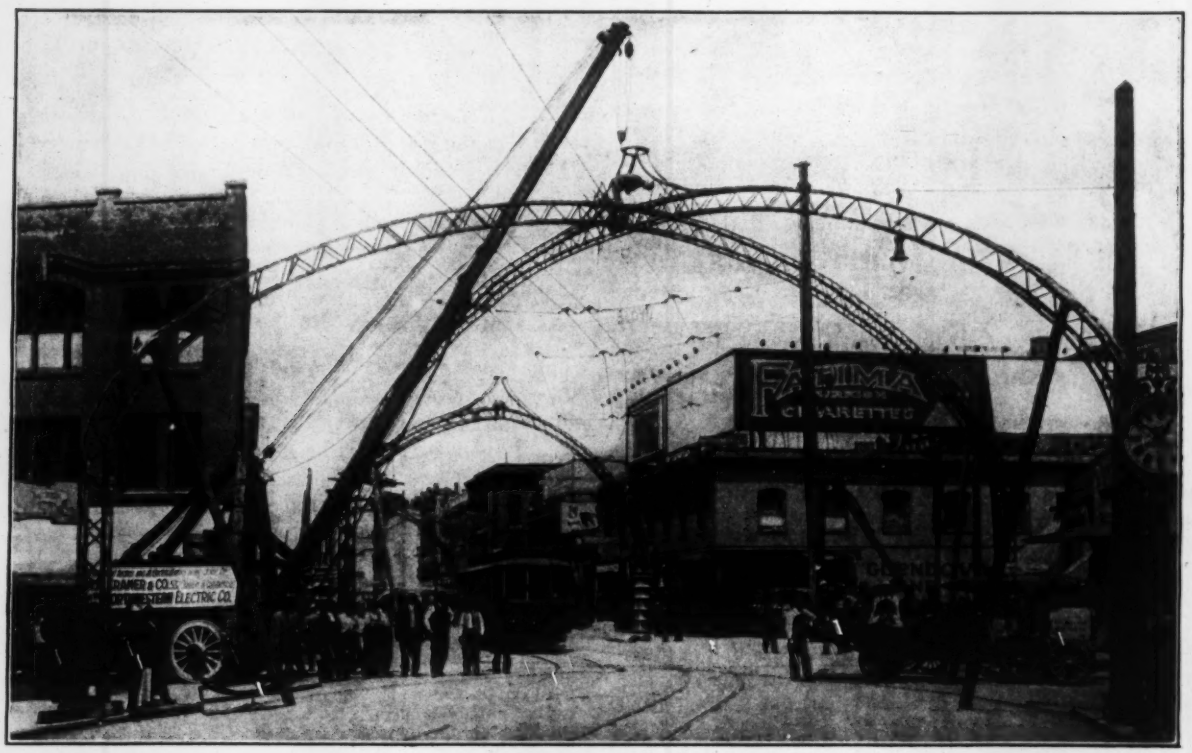


FIG. 2. TWO DERRICK-TRUCKS ERECTING SECOND ARCH OF A PAIR

Diagram for Wooden Beams

The accompanying diagram was devised to provide an easy, rapid and sufficiently accurate method for drafting-room use in the design and investigation of wooden beams of various sizes.

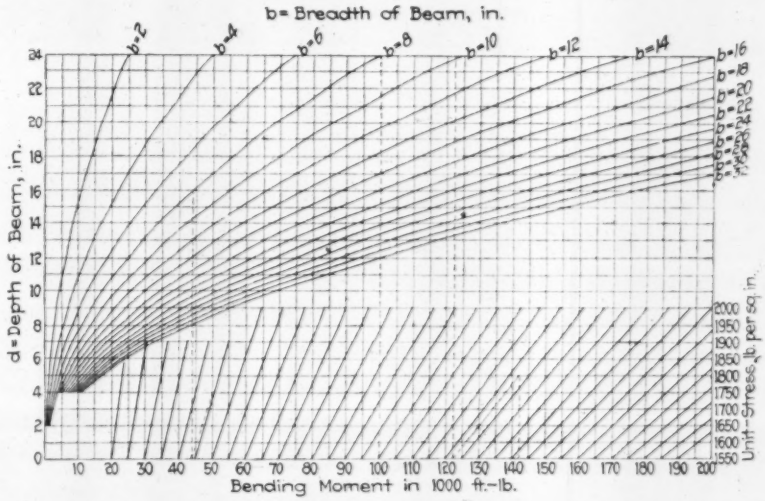
Its use is limited to unit-stresses from 1550 to 2000 lb. per sq.in., but its capacity can be increased by extending the diagonal stress-moment lines. Additional curves indicating breadth may also be drawn.

The following examples will illustrate the several uses to which the diagram is adopted:

1. Bending moment, 100,000 ft.-lb.; unit-stress, 1550 lb. per sq.in.; find beam required. Begin at 100 on the 1550 line at the bottom of the diagram and proceed vertically and select any beam whose breadth is indicated by the curve intersected and depth by the ordinate of the point of intersection. In this case the choice varies from a 32x12-in. beam to an 8x24-in. beam, between which limits any available commercial size would be adopted.

2. Bending moment, 142,000 ft.-lb.; unit-stress, 1800 lb. per sq.in.; find beam required. Begin at 142 on the 1550 line, then vertically to the 1800 line, diagonally to intersection on the 1550 line, then vertically to the intersection to the breadth curves.

3. Beam 8 in. wide, 16 in. deep; bending moment, 50,000 ft.-lb.; find stress in beam. Begin at intersection of curve $b = 8$ with the horizontal at $d = 16$, proceed vertically downward to 1550 line, then diagonally upward to the intersection of the vertical bending moment line indicating 50,000 lb. Stress 1750 lb. per sq.in., as indicated by the ordinate of this point of intersection.—W. D. Hudson, St. Louis, Mo.



A Table of Bevels

The accompanying table of bevels or offsets is given by A. D. Williams, Cleveland, Ohio. By its help a bevel can be selected in even fractions per inch and per foot. In laying off the slopes of roofs or any work that has to be framed, it frequently makes very little difference whether the slope per foot is a trifle more or less, while at the same time it may be very convenient to have the slope per *inch* an even fraction. The table has been found convenient in such cases. It gives the bevel per inch, the bevel per foot and the corresponding angle. Sometimes in selecting slopes or bevels it may even be advantageous to select a bevel per inch which will be divisible by eight.

TABLE OF BEVELS AND ANGLES

Bevel, Inches per In.	Bevel, Inches per Ft.	Angle	Bevel, Inches per In.	Bevel, Inches per Ft.	Angle	Bevel, Inches per In.	Bevel, Inches per Ft.	Angle	Bevel, Inches per In.	Bevel, Inches per Ft.	Angle
1/32	1/32	0°53′43″	11/32	3 1/32	14°52′32″	21/32	6 1/32	27°16′36″	11/32	9 1/32	37°26′19″
1/16	1/16	1 47 24	3/8	3 1/16	15 42 31	11/16	6 1/16	27 58 46	23/32	9 1/16	37 59 56
3/32	3/32	2 41 02	13/32	3 3/32	16 32 05	23/32	6 3/32	28 40 23	12/32	9 3/32	38 33 02
1/8	1/8	3 34 35	7/16	3 1/8	17 21 14	3/4	6 1/8	29 21 28	13/32	9 1/8	39 05 38
5/32	1 5/32	4 28 02	15/32	3 5/32	18 09 57	25/32	6 5/32	30 02 00	27/32	9 5/32	39 37 44
3/16	1 3/16	5 21 21	1/2	4 1/8	18 58 13	13/16	6 3/16	30 41 59	14/32	10 1/8	40 09 22
7/32	1 7/32	6 14 31	17/32	4 3/32	19 46 02	27/32	6 7/32	31 21 26	29/32	10 3/16	40 40 30
1/4	1 1/4	7 07 30	9/16	4 1/4	20 33 22	7/8	7 1/4	32 00 19	15/16	10 1/4	41 11 09
9/32	1 9/32	8 00 17	19/32	4 9/32	21 20 13	29/32	7 9/32	32 38 41	31/32	10 9/32	41 22 21
5/16	1 5/16	8 52 50	5/8	4 5/16	22 06 34	15/16	7 5/16	33 16 30	1	10 5/16	42 11 04
11/32	2 11/32	9 45 09	21/32	5 5/32	22 52 25	31/32	7 11/32	33 53 46	1 1/32	11 11/32	42 40 20
3/8	2 3/8	10 37 11	11/16	5 1/8	23 37 46	1	8 1/8	34 30 31	1 1/16	11 1/8	43 09 09
13/32	2 13/32	11 28 55	23/32	5 7/32	24 22 35	1 1/32	8 11/32	35 06 43	1 3/32	11 13/32	43 37 31
7/16	2 7/16	12 20 21	3/4	5 1/4	25 06 53	1 1/16	8 1/4	35 42 24	1 1/8	11 1/4	44 05 26
15/32	2 15/32	13 11 26	25/32	5 13/32	25 50 40	1 3/32	8 13/32	36 17 33	1 5/32	11 15/32	44 32 56
1/2	3	14 02 10	1	6	26 33 54	1 1/4	9	36 52 12	1	12	45 00 00

NOTES

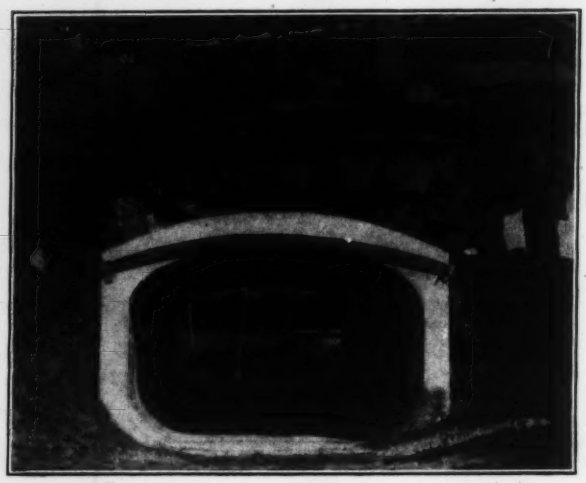
Unusual Accident in a Hydro-Electric Plant—A peculiar penstock failure recently occurred at a station in northern New York. A 9-ft. steel penstock, 2000 ft. long and under 200 ft. head, supplied two generating units, but had no surge tank connected to it. Two inclined branch pipes, closed with blank heads, were left for supplying future machines. Pressure-relief valves were depended on to prevent excessive water-hammer and assist in the speed regulation of the generating units. From some unknown cause an extreme surge was set up in the penstock and the hammer blew off the blank cover of one branch pipe. A 3½-ft. stream shot up, broke through the roof and spouted in a curved jet which excavated a big hole in the ground some distance away. The plant was temporarily flooded, but the damage, except for the hole in the roof, was much less than was to be expected.

To Prevent the Warping of a Drawing-Board the following treatment will be found most useful. Give it a thorough coat of very thin shellac before it has a chance to become warped in the slightest. Use only the very best grade of white shellac and make is as thin as possible with alcohol, and in brushing it over the surface rub it thoroughly into the pores of the wood, thus making the board thoroughly waterproof. The shellac application should be used over the entire surface. After the board has been used for a while and becomes full of thumbtack holes it is a good idea to give it another coat. Do not, however, allow a glossy surface to remain on the board, as it destroys the desired drawing surface; if a glossy surface remains, rub well with plain alcohol. Several such treatments during the life of a drawing-board tend to hold it in its original form by keeping moisture from permeating it.—Frank H. Jones, Winter Hill, Mass.

A Cement Measuring Bucket has been devised for dividing a sack of cement into two lots. The bucket is cylindrical, 10 in. diameter and 24 in. high, with a capacity of 1 cu.ft.

The arms of its bail extend down to about mid-height and their ends carry pins to which is attached an interior disk, like a stove-pipe damper. With the bail in horizontal position, the disk stands vertical, and a sack of cement is emptied into the bucket, practically filling it. On raising the bail, to lift the bucket, the disk is turned to horizontal position and thus divides the contents into two lots of ½ cu.ft. each, which can be dumped separately. This device is the invention of Mr. Cullen, of the T. L. Smith Co., Milwaukee, Wis.

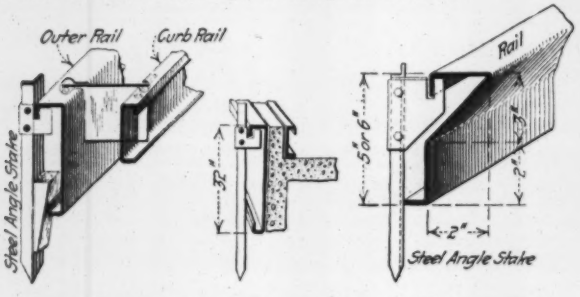
A Sectional Concrete Culvert—A sectional concrete culvert now being introduced consists of a series of blocks, each the full size of the culvert. These blocks are of reinforced concrete, made either at the site (for large jobs) or at a convenient yard and delivered at the site. They are held together by two steel rods on each side. The rods lie in grooves



SECTIONAL CONCRETE CULVERT

formed in the blocks, and pass through the ends of flat transverse bars between the blocks. The accompanying illustration shows the completed culvert, with a caterpillar tractor passing over it. This system of construction is the invention of John Gibson, of Fromberg, Mont., and the culverts have been used extensively in Western states for about four years.

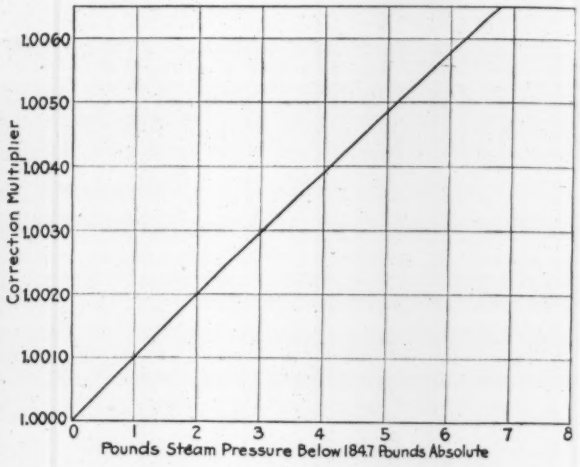
Suspended Steel Forms for Concrete Paving—A design of steel form now in use for concrete roads and sidewalks has the longitudinal members or rails suspended from stakes instead of being supported at the bottom by blocking, etc. The stakes are steel angles, each having a riveted lug with a slot to receive the edge or flange of the rail.



STEEL FORMS FOR CONCRETE PAVING, HAVING THE LONGITUDINALS SUSPENDED FROM STAKES

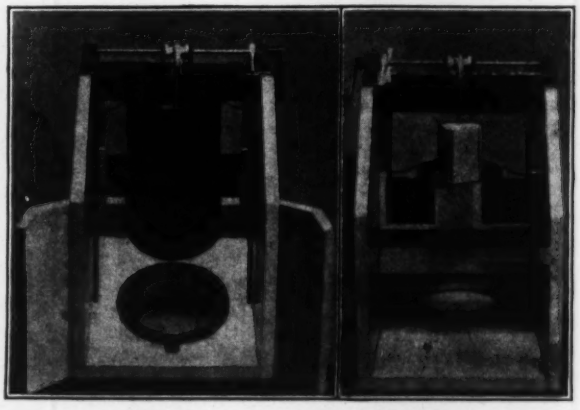
The construction is shown in the accompanying drawing. At the left and in the middle is the form for concrete curb. The larger rail is the back of the form, extending the full depth of curb and base. The smaller rail is for the face of the curb, and is attached to cross-pieces which form joints in the curb but do not extend into the base. A block or wedge against the lower flange of the back rail adjusts this in position. The drawing at the right shows the arrangement for a concrete road without curb. Here the rail is of such shape as to give a beveled edge to the concrete, which facilitates the connection of the earth or macadam shoulder for the side of the road. A plain rail can be used if desired. The rails are in 12-ft. lengths, and are of various depths to suit requirements. These steel suspended forms, manufactured by the Heltzel Steel Form & Iron Works, of Warren, Ohio, have been employed in a number of cases.

Duty Correction for Steam Variations in Pump Tests—In recent tests of the water-supply booster pumps at Roseland Station, Chicago, made by W. A. Nelson, R. W. Allerton and C. J. Bacon, the contract duty was based on 170 lb. gage and 98% dry. The moisture correction was expressed as a multiplier determined by dividing 98 by the percentage actually found. This was applied to the duty as actually obtained.



The steam-pressure correction was expressed as a multiplier applied in the same manner. It consisted of the ratio of available heat energy of steam working on a "contract-basis" Rankine cycle (between the limits of specified pressure and moisture and 0.55 lb. absolute back-pressure) to available heat energy for the same cycle on an "observed basis" (between limits of the observed pressure and 98% moisture and 0.55 lb. absolute back-pressure). To facilitate computation, the accompanying curve was plotted showing relation between pressure variation and corresponding multiplier.

Balanced Cylindrical Valve for Irrigation Service—The balanced cylindrical valve shown in the accompanying views has been built by W. T. Baker, of Pueblo, Colo., as an irriga-



tion gate. A guided steel cylindrical gate with counterweight is carried by a rope running over sheaves and a windlass on a frame above the side walls. This gate when closed rests on a metal seat in an inclined floor, the cylinder having its lower edge cut to fit. There is, of course, no unbalanced pressure on the gate since it is surrounded by water. The floors, side walls and wings are of concrete; the beams and framework are of wood or steel as desired.

A Double-Edged Scraper Bucket for dragline excavators is being built by the Raymond W. Dull Co., of Chicago, for the purpose of securing greater life for the bucket. Instead of being of the more usual rectangular form, it is approximately triangular or V-shaped in side elevation, and has the cutter or teeth fitted to the edge of the lower side. When this side becomes worn, through being dragged along the ground, the teeth are removed and placed on the other edge and the bucket is inverted so that the worn side becomes the top.

Editorials

Stresses in Bridge End-Posts

One point in the careful analysis of skew portals given by Prof. J. P. J. Williams on another page should receive attention, if all the rest of his article is neglected: namely the fact that—as he demonstrates—there are greater bending stresses in the end-posts than ordinarily are allowed for. What makes this fact important is the special vulnerability of the end-post. Several sensational accidents which occurred during the past year afford recent illustration of this vulnerability—the bridge wrecks at Attica, Ind., and Chester, Penn., will be remembered. It is no great stretch to call the end-post a weak point in the modern railway bridge.

This statement, of course, has reference to the effects of external violence. But under the circumstances it is clearly undesirable to ignore any real element of normal service stress. Therefore the extra longitudinal bending which is now shown to exist by virtue of the skew furnishes another reason for making end-posts stronger than customary practice builds them.

Specifications for Bituminous Cements

No one thing is more puzzling to the average highway engineer than writing specifications for bituminous cements and road binders. He may know what he wants; he may have found by experience what is best—but he finds it almost impossible to draw specifications open enough to admit of competition and yet describing the material wanted. Some highway authorities have abandoned even the attempt to draw open specifications, but rather have bought what they want under its trade name.

Add to these difficulties the maze of intricate tests that have been developed for tars and asphalts and the haze that surrounds their exact relation to the actual service as road binders. All these together make a hard nut for the plain, ordinary city engineer and highway official to crack, since with all his other duties he can hardly hope to become an asphalt expert.

Hence, the standard paving specifications drawn by experts and offered gratis to other engineers are a welcome aid. But how limited a faith these same experts have in their own specifications for bituminous materials is well illustrated in the following clause from the recently adopted specifications of the American Society of Municipal Improvements:

43. PREVIOUS SERVICE—The contractor will be required to show, to the satisfaction of the engineer, that the company manufacturing the asphalt cement or refined tar he proposes to use under a given specification has, for a period of at least two years, manufactured asphalt cement or refined tar in a thoroughly equipped plant, and that asphalt cement or refined tar manufactured of bituminous material obtained from a similar source to that which he proposes to use shall have been in continuous and successful use in bituminous pavements constructed by the mixing method or in bituminous-macadam pavements for a period of at least two years previous to the date of the letting in which his proposal was submitted.

Another Attack on the Los Angeles Aqueduct Foiled

Another attack on the Los Angeles Aqueduct has failed. This was an injunction suit to prevent the use of water from the aqueduct in Los Angeles on the ground that it is so badly polluted as to be unfit for human consumption. The Superior Court, after a forty-day trial, rendered an opinion which concluded as follows:

The conclusions reached in this opinion do not come from a mere preponderance of the evidence, but from an overwhelming weight of proof which leaves possible no other termination of the litigation. On the whole, the record in this trial furnishes a splendid indication of the judgment of the people of the city in acquiring and developing a water-supply from the Owens River region.

The application of the plaintiffs for an injunction is denied and the defendants will have judgment for their costs.

Rarely, if ever, have a great engineering work and a great chief engineer been subjected to so many, so virulent and so unwarranted attacks as have the Los Angeles Aqueduct and William Mulholland. The engineering profession deprecates the attacks and rejoices in their continued failure.

An Anniversary

Two years ago the end of March brought with it a tremendous upheaval in the existence of several million people inhabiting Ohio and Indiana. Their daily routine was completely disorganized; their food supply interrupted; in many cases even their water-supply cut off or else poisoned by pollution. Hundreds were dead, thousands who escaped this fate were homeless. It was the week of the great floods. War between opposing armies could hardly have dealt more savagely with the region.

How often such tremendous floods occur—or whether they will ever recur—has not yet been settled satisfactorily by the students of hydrological records. It seems a fair conclusion, however, from the available data that the average frequency of such floods could not be greater than say once in fifty years. This is a long-run average. It does not mean that there will be forty-eight more years of peace in Ohio and along the Wabash. Similar destruction may come next year, and indeed might have come this year or last.

In time of peace prepare for war; after the flood, build to protect against the next flood. This is the thought that must inevitably become controlling after a great disastrous occurrence like the Ohio Valley flood of 1913. So it has worked out indeed, if we measure the effect in terms of quantity of talk; there has been a great quantity of talk and discussion and disputation in the Central States about flood protection—chiefly negative, setting forth what could *not* be done. But if we measure the effect by actual accomplishments, we must conclude that the inhabitants of the devastated regions promptly forgot about the floods and turned again to their ordinary day's work. For practically nothing has been done in the way

of preventive work; at a few localities only—and these points of but minor damage—is actual work visible.

Following the stage of talk and vain discussion comes sometimes a period of intense action. We look forward with hope to such a period in the regions visited by the floods of 1913.

The Late Frederick W. Taylor

The sudden death of Frederick W. Taylor removes from among us one of the acknowledged leaders of the engineering profession. Although his death occurs at a comparatively early age, Mr. Taylor had fully completed the great task of his life. His great achievement was the introduction to the engineering profession and to the industrial world of what has come to be known, for want of a better name, as scientific management.

It has been said that this was not originated by Mr. Taylor. Other men before him had followed, to a greater or less extent, the practice of setting tasks for workmen and giving them instructions as to the best methods of performing the tasks. This fact, however, detracts little from the great credit due Mr. Taylor as the originator of what was in effect a revolution in manufacturing industry. What others had attempted in an isolated and partial way, he did in a thorough manner and with a clear view of the underlying principles involved and the enormous scope and possibilities of the new system. By his personal force and ability, moreover, he brought the new system into extended use in a short time. Had it lacked such a strong and powerful advocate, its development would surely have been far slower and more uncertain.

It is unfortunately true that the system which he originated has been widely misunderstood and misapplied. Beside the school of able engineers who worked with Taylor and followed his methods and in many cases improved upon them, a host of imitators has sprung up who have nearly made the word "efficiency" a byword of contempt. Misuse of the Taylor system to drive workmen beyond their strength has been one of the causes that brought against it the antagonism of the labor unions. It is worth while to say at this time that nothing aroused the righteous wrath of Taylor more than the misuse of his system by employers merely as a tool to get more out of their hands. He always believed and always urged that an essential feature to the success of his system was that the profit representing the increased efficiency resulting from its application should be equitably divided between the workers and the employer.

That many faults and imperfections have developed in the operation of Taylor's system, and of similar systems which imitators have brought forth, will be freely acknowledged by impartial observers. It remains true, nevertheless, that the system of scientific management which he to a large extent created is probably the greatest labor-saving instrument that has been developed in modern times.

New York Refuse-Disposal Bill Vetoed

Governor Whitman's veto of the bill permitting New York City to make a refuse-disposal contract for a term of 15 years in place of the present five-year charter limit continues a handicap under which both the city and honest contractors suffer. (See p. 508 of ENGINEERING NEWS of March 11, 1915, for the terms of the bill.) Unfortunately, the same handicap exists in some other cities. In Philadelphia it is far heavier, for there a one-year contract is the limit.

The folly of short-term contracts for garbage and refuse disposal has been pointed out again and again in these columns. A plant for an improved system of garbage disposal requires a large capital outlay. Under a short-term contract the contractor must either gamble on the renewal of the contract or else get a price for his services which will insure not only his expenses and a profit on his investment but, in addition, the return of his entire capital within the contract period.

Either plan is clearly against public policy. The first or gambling alternative is likely to result in political corruption or poor service. The second or prudent alternative means that within a brief period the city not only pays for service but also the entire cost of a refuse-disposal plant—which, however, the contractor instead of the city owns, but which may be worthless to the contractor unless he renews the contract.

The bill vetoed by Governor Whitman sought to eliminate risk to the city and contractor alike. It went further—it made the city a potential profit sharer. Besides spreading the recovery of capital cost over a possible period of 15 years it provided that, whatever the length of the contract, the city and not the contractor should be the owner of the plant at the expiration of the contract. The bill made it possible for the city to provide the site for disposal works and also to join in building the plant. In any case the city was to share in the profits.

Previous New York legislatures have refused to pass a bill authorizing New York to make refuse-disposal contracts for longer periods than five years. The Pennsylvania legislature has denied Philadelphia the right to award such a contract for more than one year. Governor Whitman, in his veto message, showed no sympathy with even the spirit of the New York bill.

Why, it is pertinent to ask, should New York, Philadelphia or any other city be dependent upon legislatures or governors for authority to handle as they see fit such a purely local matter as a refuse-disposal contract?

In so far as questions of public policy are involved, if state compulsion is to be used, cities should be required to let moderately long instead of short contracts for refuse disposal wherever large capital outlay is required. Any legislation on the subject should be general rather than special; otherwise the interests of political machines and contractors, and not fundamental principles of public policy, will continue to prevail.

A Phase of Jitney Bus Operation

Competition of the jitney bus with the electric car continues to be a favorite subject for discussion in every city in which the new mode of public conveyance has become popular. In a few weeks' time the jitney has spread from the Pacific coast through the Middle West, and has just reached New England. The standing puzzle is, How can the operators of the jitney busses afford to carry passengers for a five-cent fare and pay the cost of gasoline, tires and maintenance on their machines? This is especially a mystery to men who have

had some experience in keeping an automobile and a chauffeur to run it.

One of the main reasons why the jitney-bus driver is able to stay in the game is that almost invariably he owns and takes care of his own machine. In the case of most automobile owners, the biggest item in the cost of keeping a car is the garage bills for repairs; but if the man that drives the car is its owner, it will be driven and run much more carefully on the average than if the car belongs to someone else.

This principle applies to a good many other lines of business besides the operation of the jitney bus. The U. S. Post Office Department in its last annual report states that it has found the best way of securing automobile service for use in the collection and delivery of mail by carriers is to make an annual allowance to the carrier for furnishing and operating his own vehicle. In this way the driver is given a strong inducement to so run and take care of his vehicle that the cost of repairs and maintenance will be the lowest possible. Its visits to the garage will be few and infrequent compared with a government-owned vehicle where whenever anything does not go exactly to the satisfaction of the driver the easiest thing for him to do is to send it to the garage for repair or adjustment, instead of fixing it himself.

Many contractors have had a similar experience in the operation of both motor vehicles and horse-drawn vehicles. It requires constant supervision to see that drivers handle horses with care and skill, and the same thing is even more true of motors. If, however, a contractor can sublet a job of hauling to a man who owns a motor truck or a team, better and more economical use of either the horse or the motor is assured.

Greater Powers for the Interstate Commerce Commission

We recently alluded in this column to the changed attitude of railway officials toward public regulation of railway operation. A recent remarkable example is furnished in an address by Daniel Willard, President of the Baltimore & Ohio R.R., before the students of Dartmouth College on Mar. 22. Speaking of the interstate commerce law, he said:

> **The Interstate Commerce Commission should be enlarged and reorganized and its powers so broadened that it may be able to deal promptly and effectively with the various matters under its jurisdiction. It is not able to do so at the present time.**

When the interstate commerce law was enacted, in 1887, it met the united and powerful opposition of the railway companies. This opposition did not end with the passage of the law, but was continued down to recent times. The leading railway officials of the present day, however, recognize that public control has come to stay and that it is far better for the railways and the public that such control shall be exercised by Federal and State commissions, rather than by Federal or State legislation. In the campaign in the New Jersey legislature for the repeal of the full train-crew laws, the railways announced their willingness to have the size of train crews fixed by the State Railway Commission, provided the present law is repealed.

President Willard's appeal for an enlargement of the Interstate Commerce Commission and the broadening of its powers should be heeded. The laws already in force impose upon the seven men composing the Interstate Commerce Commission tasks greater and more onerous in controlling the 250,000 miles of railway in the United States than any seven men living could possibly accomplish.

It is often said that the railways are suffering from too much regulation. A more accurate statement would be that they are suffering from unwise regulation. Part of this is due undoubtedly to incompetence on the part of the personnel making up the commissions as well as to demagogic legislation; but it is also true that the Federal commission has not the authority it should have to protect the railways and the public from the evils of wasteful competition.

The Local Engineering Society Again to the Front

The importance of the local engineering society to the welfare of the profession, which was discussed in these columns in our issue of Dec. 31, has been the theme of a number of recent papers and discussions, notably of the presidential address by Harrison P. Eddy at the recent annual dinner of the Boston Society of Civil Engineers.

There are, it is true, few if any local engineering societies in this country which can boast of such activity and prosperity as the Boston Society, which is now in its 68th year, and whose strength and prosperity are indicated by its membership of over a thousand and a permanent fund in its treasury of some $35,000. What can be accomplished by local engineering societies, however, is illustrated not only by the Boston Society but by the strong and influential societies in Cleveland, Philadelphia, Pittsburgh and Chicago.

It seems worth while again to call attention to this because the present movement toward establishing local sections by the national societies of civil, mechanical and electrical engineers is, in some cases at least, operating as a serious handicap to the local societies. In San Francisco, for example, the Technical Society of the Pacific Coast, which is more than a quarter of a century old, has recently announced that it is no longer possible to maintain its organization.

If the movement to establish local branches or sections of the national societies causes the engineers in the smaller cities to be split up into three or four small groups according to their national society affiliation, while a number of other engineers who have no affiliations with any of the national societies are left without any local organization to which they may devote their energy, the result would not be to the advantage of the engineering profession at large or to the engineers resident in the local community.

In Mr. Eddy's address above referred to, after showing how "the encouragement of social intercourse among engineers and men of practical science" could be much more effectively promoted by a local engineering society than by a national society, he said:

> **A national society must of necessity confine its activities primarily to the publication of papers, researches by its committees and the development of its library—all educational functions. But a local society must do more. It must have a personal interest in and oversight of its members. It should be a sort of fraternal organization seeking to assist its mem-**

bers in every way consistent with the ideals of the engineering profession and the fundamental principles of professional ethics.

There is a growing belief among engineers everywhere that engineering organizations ought to exert an influence in public affairs. Experience indicates that this can be done more effectively by strong local organizations of engineers than by the national societies. This is another reason why it is far better that a city should have a strong local engineering society, opening its doors widely to engineers engaged in all classes of work, rather than that three or four small struggling organizations, holding occasional thinly attended meetings, should try to maintain an existence.

One of the important matters that remains to be worked out in connection with the relations between the national and the local societies is the matter of dues. Some of the national societies already follow the practice of the Canadian Society of Civil Engineers and permit part of the dues paid by their members in a locality to be devoted to the expenses of the section of the national society in that locality. It is not an impossible step from such a practice to a plan whereby similar coöperation could be effected between a local society and one or more of the national societies.

In some of the local societies, those at Boston and Pittsburgh, for example, there have long been established sections devoted to special fields of engineering work. These sections could be affiliated with the national society in their field to the advantage of both. In fact something of the sort is necessary to avoid needless and wasteful duplication of effort.

Letters to the Editor

The Architect's License Law in Illinois

Sir—Having been connected from the first with the movement to license structural engineers in Illinois, I cannot refrain from replying to the letter by "Western Engineer" in your issue of Mar. 11. It seems to me that there have been enough anonymous communications on this subject. Your readers are entitled to be spoken to frankly and to know the names of those who address them. In the case above referred to, the author is a licensed architect, high in the councils of the Illinois Society of Architects. He was honored some years ago by election to the Board of Direction of the Western Society of Engineers, where he at present constitutes a "minority of one" on this important subject.

My object in calling attention to this fact is to show that he should speak as an architect or as an individual and not as a "Western Engineer" when he addresses the engineering profession.

No one claims that the terms architect and engineer are or should be synonymous. The architects, however, have placed themselves in a false position by attempting to monopolize the designing and supervision of buildings and structures, and the engineering profession naturally declines to accept such limited privileges as the architects see fit to offer them.

We want our rights. The designing of modern buildings is an engineering problem. The architect is helpless without the engineer; not so the engineer without the architect. Even the building plans in Chicago which the law requires to bear an architect's stamp are examined and checked by engineers and not by architects.

We do not want to practice architecture, but we do want the legal rights to design and supervise buildings and structures, and the owners are entitled to the privilege of availing themselves directly of the services of engineers in the designing of buildings and structures in which engineering considerations predominate. There is no possible way of dividing buildings into engineering structures and architectural structures. Any attempt would lead to endless contention and litigation. All buildings "having foundations, walls and roof" involve "housing conditions" to a greater or less extent.

The profession of the architect and of the engineer are complementary; one the artist, the other the scientist, as applied to buildings. They should work in complete harmony, but harmony is impossible so long as the architects persist in attempting a monopoly.

We believe we have heard all the reasons given by the architects for this attempted monopoly, from the wise reasons based on the fact that architecture is undeniably the only profession dealing both with the substance and the graces of buildings as a whole, to the foolish ones based on the Greek derivation of the name—meaning "master builder." But in the end in all comes down to the fact that public safety is even now being guarded by the engineers forced to work in the employ of the architect.

But, they say, why not take the architectural examination and qualify as an architect? Because, (1) "Western Engineer's" statements notwithstanding, it is practically impossible for an engineer to pass the architectural examination before a board of architects; (2) engineers, having any pride in their profession naturally dislike to sail under false colors; (3) architects have every reason to object to the use of their name by engineers.

"Western Engineer's" classification of the various kinds of engineers now working for the proposed bill, besides being essentially untrue, is beside the point. As a matter of fact many of the most prominent professional engineers in Illinois are leaders in this movement, and as for the funds raised by the Legislative Committee no subscription, except from the Western Society of Engineers itself, has exceeded $25, and our subscription list is open to anyone who has a legitimate reason for inspecting it. In the referendum taken by the Western Society of Engineers over 90% were unqualifiedly in favor of the law.

In conclusion let me repeat that the present situation is of the architects' own making. We will be very glad indeed to meet them as equals on a common ground and to find, if possible, some method of joint registration or to coöperate with them in the adoption of a state building

code containing provisions for enfranchising our profession. Many of the leading architects are also in favor of such action, and are as much opposed as the engineers themselves to monopoly in either profession; but until that time comes we have no alternative but to work with all the means in our power either for a license of our own or for a repeal of the architects' license law.

ANDREWS ALLEN.

McCormick Building, Chicago, Ill., Mar. 18, 1915.

[We have also received a letter from Irving K. Pond, President of the American Institute of Architects, discussing the same subject, the general tenor of which can be gleaned from the following quotations:

> **Structural engineering is a minor part of architecture. It does not exceed in importance sanitary engineering—or, to put it bluntly, design and installation of plumbing. It is no more important than heating, ventilating and lighting. It is no more important than protective painting.**
>
> **The structural engineer views a work of architecture as a piece of construction which has been cloaked in a more or less pretty, though altogether extraneous, covering. He does not know architecture as a great organism developing upon principles of correct relationships of part to part, of part to whole, and beyond that, the fitting of that whole into a scheme of culture and civilization. He does not know functional beauty and cannot develop it. He does not understand when one talks of it.**

As we understand it, the Illinois Architects license law was passed for the ostensible purpose of protecting the public safety, not "functional beauty" or "a scheme of culture and civilization." No intelligent man doubts the value of fine architecture applied to buildings which are intended for uses where beauty of form and of detail is appropriate; but there are many buildings which are as purely engineering structures as a locomotive or a machine tool. It may be said that even in such structures appearance should not be ignored; but surely it is not the matter of primary importance; and in the design of such buildings, therefore, the engineer should be the responsible leader and not the architect, who is primarily an artist and not a constructor.—EDITOR.]

New York City Experience with Asphalt Block Pavements

SIR—In your issue of Mar. 18, p. 521, is an article, "New York City's Experience with Asphalt Block Pavements," by H. W. Durham, who has just retired from the office of Chief Engineer of the Bureau of Highways of the Borough of Manhattan. Under this heading your contributor deals solely with the pavements of Manhattan Borough and makes certain sweeping statements derogatory to asphalt blocks. Some of these statements are so misleading, so at variance with the facts and so obviously intended to create the impression that asphalt-block pavements have been a failure in the Borough of Manhattan that the writer desires to submit a few facts and figures and leave it to your readers to decide whether the statements referred to are substantiated by the data herewith submitted.

The official reports of the Borough of Manhattan give the following figures, showing for each year the percentage of repair and cost per square yard for both asphalt block and sheet asphalt, these figures being based in each case upon the total yardage of pavement on which the original contractor's guarantee of maintenance has expired and which is therefore subject to maintenance by the Borough authorities:

Year	Asphalt Block: Per Cent. Repaired	Asphalt Block: Cost per Sq.Yd.	Sheet Asphalt: Per Cent. Repaired	Sheet Asphalt: Cost per Sq.Yd.
1908	4.2	$0.108	15.0	$0.177
1909	4.5	0.109	12.0	0.117
1910	6.6	0.140	14.1	0.113
1911	9.0	0.172	17.0	0.174
1912	5.4	0.098	11.8	0.141
1913	3.3	0.059	8.8	0.132
Total 6 yr.	33.0	0.686	78.7	0.854
Average 6 yr.	5.5	0.114	13.1	0.143

In addition to the regular repair work, as set forth, there occurs year by year a replacement of old pavements through the medium of new contracts, having the usual maintenance clause, so that the total replacement consists of two items, repair and repaving. In order to get a correct idea of the actual wear and tear on the pavements of Manhattan, it is necessary to combine these two items and show the total replacement. The figures in the following table have been prepared from data furnished in the official reports of Manhattan Borough, and for the purpose of direct comparison the same series of years is used:

Year	Asphalt Block: Per Cent. Repaved	Asphalt Block: Per Cent. Repair Plus Repaving	Sheet Asphalt: Per Cent. Repaved	Sheet Asphalt: Per Cent. Repair Plus Repaving
1908	1.0	5.2	1.2	16.2
1909	0.0	4.5	6.8	18.8
1910	2.3	8.9	7.4	21.5
1911	16.1	25.1	12.6	29.6
1912	6.8	12.2	21.7	33.5
1913	4.3	7.6	17.0	25.8
Total 6 yr.	30.5	63.5	66.7	145.4
Average 6 yr.	5.1	10.6	11.1	24.3

These figures show for the entire Borough of Manhattan that asphalt blocks have been replaced by repair and repavement, for the period named, to the average extent of 10.6% per year, indicating an average life of slightly under 10 yr. in addition to the original contract period of maintenance. Similarly for sheet asphalt the average is 24.3% per year, indicating an average life of slightly over 4 yr. in addition to the original contract period of maintenance.

Your contributor expresses the opinion that these figures are not truly comparative, but offers no facts in support of that opinion. The fact is that the figures, in both cases, represent the wear and tear on pavements scattered all the way from the Battery to the northernmost limits of the Borough.

There are available, however, additional data on this subject showing the cost of maintenance per square yard per year on both asphalt blocks and sheet asphalt for the entire Borough of Brooklyn, where the traffic conditions, and consequent wear and tear, are very much lighter than in Manhattan. The following figures apply to the total yardage of pavement on which the original contractor's guarantee has expired:

Year	Block Asphalt, Cost per Sq.Yd.	Sheet Asphalt, Cost per Sq.Yd.
1909	$0.007	$0.028
1910	0.011	0.028
1911	0.024	0.034
1912	0.024	0.029
1913	0.012	0.035
1914	0.017	0.02
	$0.095	$0.174
Average 6 yr.	$0.016	$0.029

Your contributor makes the sweeping statement that "where asphalt block has been laid under heavy traffic conditions in the Borough of Manhattan it has failed to give satisfactory service," and cites as a notable instance Broadway north of Manhattan St., which pavement, "among the worst in the city, has already been repaved

with granite block on the hill and with sheet asphalt on the level portion." He does not apparently consider it at all pertinent to indicate that only a small portion (about 35,000 sq.yd.) has been repaved out of a total of 275,000 sq.yd. of asphalt blocks on Broadway between Manhattan St. and the city line.

Reference to the "Blue Book" for 1913 (the official pavement record of the Borough of Manhattan), p. 9, brings out some very illuminating official information in regard to the percentage of repair required on this section of Broadway. The "Blue Book" shows that Broadway from the north side of Manhattan St. to 135th St. was paved with asphalt blocks and accepted Oct. 31, 1906; guarantee expired Oct. 31, 1911; no repairs were required in 1911, and repairs were made during 1912 to the extent of only 4%. This is the repaved hill section.

This same page of the "Blue Book" affords what is seldom obtained—a direct comparison between the wearing qualities of two different types of pavement on the same thoroughfare and subject to the same traffic conditions. The "Blue Book" gives the following record:

Location	Class of Pavement	5-Yr. Guarantee Expired	Per Cent. of Repairs 1910	1911	1912	Total per Cent. Three Years
Broadway, west side, from 110th to 119th St.	Sheet asphalt on concrete	Apr. 1, 1910	25	32	7	64
Broadway, from 119th St. to south side Manhattan St.	Asphalt block on concrete	Aug. 7, 1910	00	00	11	11

The writer is also compelled to take exception to the statement that "no instance can be shown where asphalt block has continued to have a satisfactory service under dense traffic similar to that which has been shown for many years by the sheet asphalt on Fifth Ave." The heavy traffic section of Fifth Ave. from 9th St. to 59th St. was paved with sheet asphalt, the contractor's guarantee expiring Apr. 15, 1913. Three months later, in July, 1913, contracts were awarded (thus putting new maintenance guarantees immediately into effect) covering the entire section except from 25th to 34th St., where high-pressure water mains were under construction.

It thus appears that Fifth Ave. has been under maintenance by contractors for many years, and is now. The surface of the sheet asphalt is maintained by the contractor, in accordance with the obligations of his contract, in precisely the same manner as every asphalt block surface has been maintained by the contractor under the terms of his contract. It appears from the record, however, that the necessity for letting new contracts followed with astonishing suddenness the expiration of the original guarantees in the case of Fifth Ave.

The reference to the traveling, or creeping, of asphalt blocks under heavy traffic ignores the fact that for over two years efficient and successful methods have been in general use effectively preventing the tendency of the blocks to push out of line under heavy traffic. At any rate, anchor blocks have been very extensively used, except in the Borough of Manhattan.

In no way does the article appearing in your issue of Mar. 18 put forth statements more diametrically opposite to the actual facts than those in reference to the repair of asphalt block pavements, wherein imaginary and hypothetical difficulties are conjured up in the apparent effort to make it appear that what has been successfully, economically and effectively done over a period of 30-odd years is now impossible of performance. The maintenance of asphalt block pavements is a subject which, if introduced at all, would require much more space than can properly be used here.

EDWIN J. MORRISON,
President, The Hastings Pavement Co.

New York City, Mar. 29, 1915.

Competition by Professors in Engineering Schools

Sir—"Consulting Engineer," in ENGINEERING NEWS, Feb. 11, 1915, has well expressed the prevailing sentiment among the *practicing* members of our profession when he questions the professional ethics of those *teaching* members who appropriate for private gain the time and talent which belong to the student.

In several of our prominent state educational institutions this practice has grown to such proportions as to be little short of scandalous. In one instance coming under the writer's observation forty senior civil engineers met and unanimously resolved that they would endure it no longer, but would leave the institution at once.

Not many months ago the Dean of the Engineering Department of another state institution was competing for an engineering assignment of importance, and used the expression: "I will furnish student labor free if you will award the work to me."

A rather important piece of work was assigned last week in a Western city to an engineering professor in a prominent institution, who, like many others, maintains one office *inside* and one *outside* the university grounds. He is Professor —— *inside* the fence, and —— & —— *outside*. In the competition were men of prominence in the profession who had no "student labor free" or free library and equipment, but instead are compelled to maintain extensive and expensive staffs and well equipped offices and libraries. Some of the competitors had traveled 1000 miles at great expense only to find the work was to be assigned to a man who is supported by a state institution, and at the same time competing with her own graduates for outside work.

The writer knows of one head of department who is said to give up 75% of his time to private practice, and two others who at this writing are drawing full time, not only from the state, but also from outside sources.

The one argument for the practice is that it enables the teacher to qualify himself to teach practical things.

The remedy is to regulate such practice, as has been done by the University of Pennsylvania and the University of Minnesota (ENGINEERING NEWS, Mar. 4, 1915, p. 453), with the additional provision that *all* fees thus earned shall be turned into the treasury of the university.

The graduate engineers should not be subjected to this ruthless competition from the professors in their own Alma Mater. Besides being wrong in principle, it is exceedingly unfair not only to the graduate engineer but also to the student engineer who pays for and is entitled to receive the full time of his professor. After all, we are not finding fault so much with selfish man as we are with the system and with the trustees who are responsible.

ANOTHER CONSULTING ENGINEER.

March 8, 1915.

Sewage-Treatment Experiments with Aeration and Activated Sludge*

By Edward Bartow† and F. W. Mohlman‡

Experiments on the purification of sewage by aëration in the presence of activated sludge were begun a few months ago in the laboratory of the Illinois State Water Survey at the University of Illinois. With the advice of Prof. G. J. Fowler, of the University of Manchester, England, the experiments are following the lines described by Ardern and Lockett.§

Our first experiments were made in bottles of 3-gal. capacity. Later we constructed a tank 9 in. square and 5 ft. deep, with plate glass at the front and at the back. A porous plate was placed 4 in. above the bottom. An inlet for air and an outlet for any water which might pass through the plate were provided in the space below the plate. Compressed air furnished by the university power plant is used. All air is measured through an ordinary gas meter. The purified sewage is removed by means of a siphon. Experiments have been carried out in the laboratory at room temperature, thus far, with no special precautions to regulate the temperature.

For our experiments fresh sewage collected from the Champaign main sewer is used. It is a fairly strong domestic sewage, with no trade wastes.

Aëration of Raw Sewage without the Addition of Sludge—Air has been blown into five separate portions of sewage until complete nitrification was accomplished, which has taken from 15 to 33 days. The best result was obtained in the tank, where the air was distributed through the porous plate. For all analyses, samples of the supernatant liquid were taken after one hour settling without filtration. In each case the *free ammonia* nitrogen was almost quantitatively changed to *nitrite* nitrogen, then the *nitrite* nitrogen in turn was changed almost quantitatively to nitrate nitrogen. (See Parts I and II of table.)

NITRIFICATION OF SEWAGE, UNIVERSITY OF ILLINOIS EXPERIMENTS
(Parts per Million)

Date	Days	Nitrogen as Free NH_3	Alb. NH_3	Nitrites	Nitrates
I—No Activated Sludge Present					
Dec. 18	0	38.00	5.20	0.07	0.37
Dec. 19	1	30.00	4.20	0.02	0.38
Dec. 21	3	28.80	4.00	0.11	0.45
Dec. 28	10	22.00	3.60	5.00	0.20
Dec. 29	11	8.80	2.60	16.00	0.40
Dec. 30	12	1.60	2.40	23.00	1.00
Dec. 31	13	0.36	1.88	28.00	2.00
Jan. 1	14	0.16	1.48	31.00	1.00
Jan. 2	15	...	...	33.00	...
Jan. 4	17	...	...	33.00	...
Jan. 5	18	...	...	30.00	...
Jan. 6	19	0.28	1.92	27.00	5.00
Jan. 7	20	0.44	1.84	14.00	18.00
Jan. 8	21	0.28	1.68	0.30	31.70
Jan. 9	22	0.24	1.60	0.05	31.95
II—No Activated Sludge Present; Uniform Distribution of Air through Porous Plate					
Jan. 4	0	36.00	6.60	0.01	0.71
Jan. 7	3	34.00	3.40	1.20	0.60
Jan. 11	7	0.40	3.00	32.00	2.00
Jan. 18	14	0.60	2.60	7.50	18.50
Jan. 19	15	0.80	2.20	0.10	25.90
III—Activated Sludge Present in Ratio of 1 Part of Sludge to 5 Parts of Sewage; Uniform Air Distribution					
Feb. 24	0*	27.00	...	0.05	0.59
Feb. 24	1	13.00	...	2.40	6.00
Feb. 24	2	8.20	...	2.80	10.80
Feb. 24	3	3.70	...	3.40	15.00
Feb. 24	4	0.20	...	2.60	18.60
Feb. 24	5	0.20	...	0.30	22.10

*The remaining figures in this column are for hours instead of days.

Aëration with Sludge—The supernatant liquid was siphoned off and a fresh portion of sewage added to the sludge. In this, the second treatment, the effect of a small amount of sludge is nicely illustrated by the reduction of the time required for complete nitrification from 15 to 4 days and the reduction in the amount of air used from 4830 cu.ft. to 1270 cu.ft. Thirty-four parts per million of free ammonia nitrogen in the raw sewage produced 23.8 parts per million of nitrate nitrogen in the supernatant liquid.

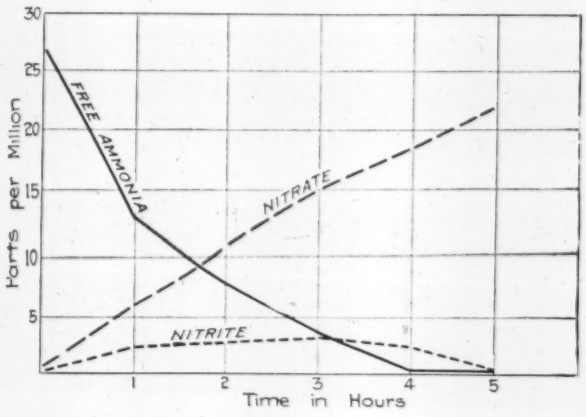


Fig. 1. Sewage Nitrification with Activated Sludge Present
(One part of sludge to five parts sewage)

The supernatant liquid was again siphoned off, fresh sewage added and aëration continued. In this, the third treatment, nitrification was complete in two days, and but 720 cu.ft. of air was used. Thirty-three parts per million free ammonia nitrogen produced 22.3 of nitrate nitrogen. In the twelfth treatment the purification was completed in less than eight hours with the use of less than 128 cu.ft. of air, and 36 parts per million as free ammonia nitrogen produced 29.5 parts per million of nitrate nitrogen. In the thirty-first treatment, with sludge and sewage in the proportion of 1 to 5, purification was complete in less than five hours, using 35 cu.ft. of air. This is equal to 0.20 cu.ft. per sq.ft. of surface area per min., or about 3 cu.ft. per gal. of sewage. We have not yet attempted to determine the minimum amount of air required.

Samples taken at the end of each hour of aëration during some of the treatments have been tested for stability. A sample taken at the end of one hour aëration in the thirty-first treatment had not decolorized methylene blue at the end of 12 days. Since in one hour nitrification was not complete, it is, therefore, evidently unnecessary to obtain complete nitrification in order to obtain a stable effluent.

The progress of nitrification in the presence of activated sludge is apparent. (See Part III of table, also Fig. 1.) Analyses indicate that there is no quantitative conversion of free ammonia to nitrite, followed by oxidation to nitrate, but that nitrates are formed simultaneously with nitrites.

The number of bacteria was determined during one

*Abstract of a paper read before the American Chemical Society at New Orleans, Apr. 1, 1915.

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§"Jour. Soc. Chem. Industry," 33, 523-39 (1122-4). Since Ardern and Lockett have abandoned for the present experiments with continuous-flow devices, we also are confining our experiments to an intermittent system.

treatment. Samples were taken after one hour settling. The raw sewage showed a bacterial content of 750,000 per c.c. The supernatant liquid, after aëration and settling one hour, showed but 20,000.

Through the courtesy of Frank Smith, Professor of Systematic Zoology, University of Illinois, biological examinations have been made of the sludge. Among the microscopic animals found are many Vorticella and Rotifera, but the predominant organism is an annelid worm, known as Aeolosoma hemprichi. This organism is about 2 to 5 mm. long and quite slender. It abounds in various kinds of freshwater bodies where there is an abundance of decaying organic material and thrives especially well where there is much fermentation and in waters contaminated with sewage, provided there is an abundance of oxygen.

It belongs to a group of worms in which reproduction occurs very rapidly by asexual methods. A fission zone is formed near the middle of the body of the parent worm and develops the head of one daughter worm and the tail of the other, and thus two new worms are formed from one. This requires not over two or three days and is repeated for an indefinite number of generations.

They feed greedily and almost continuously on any small organic particles that they can obtain and presumably destroy at least their own weight of organic matter every day, and probably more. Because of the mode of reproduction, it takes but a short time to produce extensive colonies with great capacity for the destruction of organic material.

SLUDGE—The activated sludge has evidently been developed by the multiplication of these worms originally present in the sewage, and the species found at varying

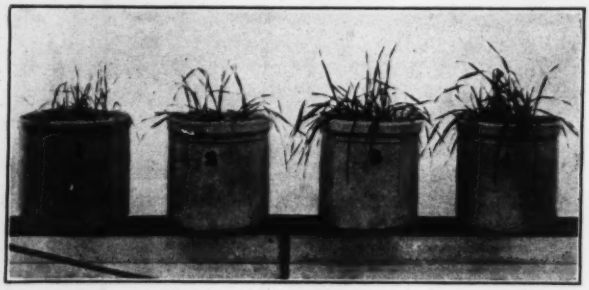


FIG. 2. EFFECT OF ACTIVATED SLUDGE ON WHEAT

(Each pot contains pure sea sand to which the same amount of plant foods except nitrogen have been added. No. 3 contains 20 grams of dried activated sludge. No. 4 contains the same amount extracted with ligroine. No. 2 contains an equivalent of nitrogen from dried blood and No. 1 contains no nitrogen. The view was taken 25 days after the wheat was planted)

points might differ. The sludge does not have an unpleasant odor, owing to the fact that it consists largely of living organisms. If kept for a long time in a moist condition without air it will putrefy.

COMPOSITION OF SLUDGE—Analyses of the sludge made by W. D. Hatfield have shown the following results: After drying first on the water bath and then for three hours in an oven at 100° C. the loss, or moisture, was 95.54%. The dried material contained 6.3% nitrogen, 4% fat, 1.44% phosphorus, equal to 3.31% P_2O_5 and 75% of volatile matter by loss on ignition.

From these chemical data the dried sludge would evi dently have value as a fertilizer. If we calculate the value as 20c. per lb. of nitrogen and 12c. per lb. of phosphorus, it would have a market value of $29 per ton. In order to determine whether the theoretical value would correspond to the actual value four pot cultures were started. [See accompanying illustration and explanatory note.—EDITOR.]

A plant to operate on a larger scale is under construction.

A Centrifugal Pump with 87.8% Efficiency

A pump recently installed in the pumping plant of the Old River Rice Irrigation Co., Mont Belvieu, Tex., about 25 miles southeast of Houston, has shown on test an efficiency of 87.8%. The pump is a 40-in. horizontal shaft double-suction type with volute casing, having a capacity of 40,000 gal. per min. against 43-ft. total head, direct connected to a horizontal cross-compound four-valve engine, and running at a speed of 200 r.p.m. The impeller, of cast iron, is an inclosed design in which hydraulic thrust is reduced to a minimum. It is keyed on a 16-in. shaft and held in longitudinal position by steel centering rings. The pump discharges underneath horizontally into a long-radius expanding 45° bend, pointing upward. Beyond this is a 30-ft. length of straight pipe, another 45° bend, and a stretch of straight horizontal pipe leading into a flume.

In the tests, the suction head was measured with a mercury U-tube on each leg; the suction proved to be practically balanced. The discharge head was also measured with a mercury U-tube. Discharge velocity was taken with a Pitot tube, about 10 ft. away from the first bend; ten readings were taken—across the pipe at the centers of equal area. As the discharge pipe could not be readily calipered, the outer circumference was taken with a steel tape, and the diameter and area determined from this, making allowance for the thickness of metal (¼-in. wrought iron). The engine speed was determined by counting, and horsepower determined from indicator cards. The average results of an 8-hr. run are given in the accompanying table.

AVERAGE RESULTS, 8-HR. RUN OF 40-IN. WOOD-D'OLIER PUMP. OLD RIVER RICE CO., MONT BELVIEU, TEX.

R.p.m.	193.35
Suction head, ft.	13.75
Discharge head	28.50
Total head, corrected	42.74
Discharge, cu.ft. per sec.	101.97
Discharge, gal. per min.	45.76
Water horsepower, corrected	494.57
Ind. horsepower (319.31 + 292.85)	612.16
Mech. effy. engine (manufacturer's)	0.92
Combined effy. engine and pump, corrected	80.79
Pump effy. $\left(\frac{80.79}{92}\right)$	0.878

The pump was made by the D'Olier Centrifugal Pump & Machine Co., of Philadelphia, after a design by A. B. Wood, Mechanical Engineer of the New Orleans Sewer and Water Board. The driving engine was made by the Harrisburg Foundry & Machine Co., Harrisburg, Penn. The test was conducted by S. G. F. Haas, Technical Engineer of the New Orleans Sewer and Water Board.

The Pennsylvania Railroad System, according to its "Annual Record of Transportation Lines," just issued, has now 11,794 miles of main line and 26,419 miles of track. Of the total mileage, 3734 miles are double track, 820 miles have three tracks, and 635 miles have four tracks. The Pennsylvania R.R. Co. has 92,225 different stockholders, more than a third of whom live in Pennsylvania, and more than half of them in the 13 states which the system reaches.

News of the Engineering World

Reorganization of the Idaho Highway Department

A law recently enacted by the State of Idaho, provides for a Highway Commission of three members, two appointed by the Governor to hold office for three years and the Secretary of State, who will be Secretary of the Commission. A State Highway Engineer will be appointed at an annual salary of $3600. The law provides for the employment of convict labor to be paid at the rate of 50c. per day.

Counties are to receive 60% of the motor-vehicle license money collected within their borders and the other 40% is to go to the Highway Commission. The license fee is based on horsepower as follows: Under 30 hp., $15; 30 to 40 hp., $20; to and including 50 hp., $40; motor cycles $5 and dealers $35 for each make of car carried. These taxes are to be collected by the county tax collectors.

Flood-Protection Work at Indianapolis

Bids for flood-protection work along the White River at Indianapolis are to be opened on Apr. 23. The estimated cost is approximately $570,000. There will be about 4½ miles of levee (with concrete riprap paving), retaining walls for street approaches, and river-front retaining walls where the property is too valuable to be taken for the slope of a levee. The work will extend along the west bank of the river from the Belt Railroad on the south to 14th St. and Belmont Ave. on the north. It will protect from future floods the entire area of the city west of the river which was submerged during the great flood of 1913. The flood-protection work now in progress at Indianapolis along Fall Creek, a tributary of the White River, was described in ENGINEERING NEWS, Dec. 3, 1914.

Pasadena Joint Sewage-Works

Joint sewage-disposal works for Pasadena, South Pasadena and Alhambra, Calif., are to be designed by a board of engineers consisting of R. V. Orbison, City Engineer of Pasadena, acting as President of the board, C. E. Hewes, City Engineer of Alhambra, acting as Secretary, and John McMillan, City Engineer of South Pasadena. The intention is to design works, the effluent from which may either be used for irrigation or else turned "into any stream without contaminating it." The board is seeking to collect information regarding every sewage-treatment plant in the United States and Canada on blank forms provided for the purpose. Any sewage-works officials who have not seen a copy of the blank form can obtain one by addressing the Secretary of the board, as given above. Those who will fill in and return the form will be supplied with a summary of the information collected as a result of the inquiry. It may be added that for many years past the city of Pasadena has maintained a large sewage farm on which it has raised, among other things, oranges and walnuts. So far as we know, this is not only the largest sewage farm now in operation in the United States, but is also one of the very few sewage farms in this country worthy of the name.

Boston's Ten-Year Street-Lighting Contract

An interesting contract has been signed by the City of Boston and the local Edison Electric Illuminating Co., covering the street lighting of a considerable part of the city for the next ten years. Some 4500 6.6-amp. magnetite arc lamps are called for, a few 16,000-cp. flaming arcs for certain squares and a considerable number of incandescent-filament lamps of from 40 to 200 cp. A temporary price has been made of $87.53 for each of the magnetite lamps per year. (The price was $103.54 under previous contract.) This corresponds to $36 per lamp per year plus a running expense of 1.6c. per lamp per hour, less a 10% discount for long contract. The prices for other lamps vary from (1) $10.80 per lamp per year plus ¼c. per lamp per hour running costs for a 40-cp. lamp up to (2) $42 per lamp per year plus 3.2c. per lamp per hour for a flaming arc. Both parties agree jointly to request the Massachusetts Gas and Electric Light Commission to determine whether these prices are fair or not, considering length of contract, discount, etc.

Lamps of any type may be substituted from time to time for any lamps in use, provided the city pays the total net expense to the company of changing (credit is allowed the city for the market value of the displaced property). The candlepower of a new type is not to be substantially less than that displaced. The fixed-cost factor in the rate for substituted lamps is to be the same as that of the lamps displaced, and the running-cost factor is to be determined by agreement or arbitration. To allow the installation on the existing arc circuits of high-efficiency incandescent lamps that may be developed, the company will substitute at prices established by the Board of Gas and Electric Light Commissioners.

The contract provides an 8-hr. day for street-lighting employees and the city is released from liability for the unexpired term in case of purchase of the whole or part of the company's plant. The contract cannot be terminated at the expiration of the ten years without 60 days' written notice. The prices in the contract apply as from July 1, 1914, which gives the city a refund of some $32,700 on service rendered.

Railway Mileage under Construction in Canada

Canada had 22,891 mi. of railway under construction on June 30, 1914, according to the annual report (just issued) of the Comptroller of Railway Statistics, J. L. Payne. The increase in operating mileage for the year

ending June 30 was 1491 mi., in addition to 309 mi. of double track laid during the year.

The heaviest construction is under way, or projected, in the western provinces, and is as shown by the following mileage tabulation:

Province	Surveyed	Under Contract	Completed but Not in Operation
Alberta	3054	804	1188
Saskatchewan	3458	340	555
British Columbia	3577	1234	698
Manitoba	354	108	134
Ontario	532	1841	835

The capitalization of Canadian railways increased by nearly $277,000,000, now totaling $1,808,820,761. The year was much less profitable than the preceding one; net earnings were $64,108,280, or $10,582,723 less than for 1913. Operating expenses amount to $178,975,259, or $3,036,431 less than for 1913.

Contract Void; Bidders Not on Same Basis as to Time of Completion

A contract awarded to a bidder who was not the lowest was thrown out by a Supreme Court decision in Pittsburgh last week. The Board of Education had awarded the Schenley high-school contract to James L. Stuart on a bid of $710,600, nearly $60,000 above the lowest bid; Stuart had guaranteed completion by Oct. 1, 1915. The calls for bids did not specify a desired time of completion, but required bidders to fix their time in the bid and guarantee it. The court held that this makes it doubtful whether competitive bids were properly invited or properly made. If all the bidders had been put on a common basis as to time of completion, "who could say that the school board would not have accepted a lower bid as being the best?" Stuart has already done a great amount of work on the foundation, and it is expected there will be litigation over the payment for this.

Clearance Widening on East River Bridges

Work has started on the widening of the Williamsburgh Bridge and the Manhattan Bridge over the East River at New York, to increase the side clearances on the rapid-transit tracks. The work on the Manhattan Bridge is not very extensive, the widening being necessary at only a few points. On the Williamsburgh Bridge the promenade columns on both sides of the tracks, for the entire westerly approach, have to be reconstructed to make them 6 in. narrower. In the suspension structure the rapid-transit tracks are at a higher level, so that the columns do not interfere. However, on both land spans at the points where the cables rise above the floor several columns built wide enough to pass around the cables infringe on the clearance. At these points the cables (inner pair only) will be jacked apart 24 in. in connection with rebuilding the columns; about 50 tons jack pressure will be required in the jacking strut, which will then be converted into a permanent spreader by riveting a middle section in place. Several through plate-girder spans in the approach also have to be widened by spreading the girders.

Land Drainage in Minnesota

During the last few years a great impetus has been given to land drainage in Minnesota by the realization of the agricultural value of the vast areas of swampy and wet lands within its borders. The total area of the State is 84,286 sq.mi., divided between woods and prairies about as 5 to 3.

In 1860 Congress granted the State of Minnesota all the swamp and overflowed lands within its boundaries which had not theretofore been otherwise disposed of. The total area of these swamp lands amounted to 5,890,199 acres. To date 403,515 acres of these swamp lands have been sold at auction to prospective settlers in tracts not exceeding 320 acres each. In addition to these state swamp lands there are a great many acres of privately owned wet lands.

There have been constructed in the state or are now under contract 8942 mi. of county and judicial ditches, requiring the removal of 77,000,000 cu.yd. of material and benefiting 6,000,000 acres of land. The total cost of work completed and the estimated cost of work under contract amount to $12,500,000. The State Drainage Commission has constructed, or has under contract, 1157 mi. of ditches, involving the removal of 17,000,000 cu.yd. of material and benefiting 1,400,000 acres, at a total cost of $1,600,000. Some of the largest projects are yet to be undertaken, and surveys and estimates are now being made for this work.

The Milwaukee Sewage Tests

A description of the Milwaukee sewage-treatment station and a summary of the results obtained during the first three months of operation (ending Nov. 30, 1914) occupy twenty pages of the first annual report of the Sewage Commission of that city, which has just been published. Coarse-screened sewage from a combined sewer which receives trade wastes is pumped to a grit chamber and passed at will through bar screens with ¼-in. spaces or else through wire screens with 16 meshes per lin.in. The sewage then goes to either (1) an Imhoff tank, (2) a chemical precipitation tank (lime and iron) or (3) a colloiding tank containing slate on edge and provided with a forced aeration system. The effluent from each of three kinds of tanks is applied to a separate sprinkling filter, by means of a Taylor spray nozzle. Some of the Imhoff-tank effluent is treated with liquid chlorine (Electro Chemical Gas Co. apparatus) and provision is made for chlorinating the other tank effluents. To simulate final-effluent outfall conditions, chlorinated sewage is passed through a series of parallel channels, designed to give the same flowing-through period as the time of effluent flow through the Milwaukee outfall sewer.

Sprinkling filters of different depths are being tested; their effluent goes to final settling tanks. To aid in testing sludge, including determinations of fertilizing value, a Kelly pharmaceutical filter press will be used. Large-scale studies of activated sludge are to be made under the direction of Dr. Gilbert J. Fowler, of Manchester, England. Devices for measuring sewage, air, chemicals and power have been freely installed.

Geo. H. Benzenberg is chairman and T. Chalkley Hatton is chief engineer of the Milwaukee Sewerage Commission. Wm. R. Copeland is chief chemist and bac-

teriologist of the testing station. Mr. Copeland concludes, after three months of operation, that the Milwaukee sewage can be readily purified. He states that liquid chlorine "destroyed over 99% of the bacteria in the Imhoff tank effluent, and killed nearly all of the sewage forms that were present." The slate tank seems to have removed only a little more suspended and organic matter than the Imhoff tank.

A Building Inspectors' Conference

A conference of building commissioners and inspectors is to be held at the Hotel Astor, New York, on May 14, 1915, the day after the end of the annual meeting of the National Fire Protection Association. The Conference is being called by a committee made up of building-department officials in a number of the larger cities, and information regarding it may be obtained from the secretary, Sidney J. Williams, State Building Inspector, Madison, Wis. The questions to be discussed at the Conference include the technical details of the building inspector's work and the educational methods which can be used to secure a better popular understanding of the requirements of good building.

Utilizing the Surplus Waters of the Los Angeles Aqueduct

As another step in solving the problem of disposing of the surplus waters of the Los Angeles Aqueduct, an area comprising more than 100,000 acres voted, 681 to 25, for annexation to the City of Los Angeles on Mar. 20. The district includes practically all the irrigable area of the rich San Fernando Valley, including the territory between the northwest limits of Los Angeles and the outlet of the aqueduct, and extending some miles west of the aqueduct. (See ENGINEERING NEWS, p. 344, Feb. 18, 1915.) To make the annexation effective the electorate of Los Angeles also must vote favorably upon the proposition. The election for this purpose will be held May 4, and if carried the area of the city will be more than doubled. The incorporated towns of San Fernando, Lankershim, Owensmouth and Burbank, whose locations are in the valley, are not included within the annexed area. The new district, in voting to annex, agreed to assume its proportionate share of the cost of the aqueduct and other municipal enterprises of a revenue-producing character, bonds for which comprise 90% of the city's present indebtedness. As an irrigation district, a part of the valley has already voted $2,660,000 for the installation of a distribution system of steel pipes.

Anticipating that the city will vote favorably upon the question, despite the fact that there is an organized opposition to the proposal, the Los Angeles Water Department, within forty-eight hours after the election, began the construction of a temporary unlined, open ditch leading northwesterly from the Lower San Fernando Reservoir. This ditch, known as the Zelzah ditch, is to be 12 ft. wide, 3 ft. deep, and 7 mi. long, and is designed to carry a flow of 10,000 miner's inches. The work is being undertaken with two steam shovels, and it is expected that at least 10,000 acres can be put under intensive cultivation from this source during the coming summer.

Piping Brine across Oregon

The State of Oregon a few days ago leased Lakes Abert and Summer, in the southern part of the state, to Jason C. Moore, of New York City, representing a group of Eastern capitalists. The term is 40 years and a minimum annual royalty of $25,000 is required.

These lakes are each about 16 mi. long by 6 wide, and their waters contain immense quantities of salt, soda and potash. A recent analysis during the spring dilution showed 1.58 oz. of potassium sulphate, 10.30 of sodium chloride and 23.42 of sodium carbonate, per cu.ft. The density is reported to vary from 3½ to 6 lb. per cu.ft., according to the season. It is the intention of the leasing syndicate to separate these chemical products for the market.

The lakes are in a basin of the Cascade Mountains at an elevation of about 4100 ft. It is proposed to lay 250 mi. of 14-in. wood-pipe line across the state, and down the valley of the Deschutes River to its junction with the Columbia. Here a refining plant will be erected where there is good boat and rail transportation and abundant water power. Suitable power sites have already been secured and it is proposed to proceed with their development at an early date. By diverting the Ana River flowing into Lake Summer and with the aid of solar evaporation any desired concentration of brine can be secured for the pipe line.

A total expenditure of about $5,000,000 is required for this project; it is reported that this capital has been secured and that work will begin on the completion of the engineers' plans.

Reorganization of Engineering Bureaus, Department of Agriculture

As announced in our issue of Mar. 11, p. 509, the annual appropriation bill for the U. S. Department of Agriculture established an Office of Public Roads and Rural Engineering, including the present Office of Public Roads and certain bureaus now under the Office of Experiment Stations.

A large part of the other work now done by the Office of Experiment Stations and the coöperative extension work in agriculture performed by the Department with the various state agricultural colleges will be taken care of by a new bureau known as the States Relation Service. During the next fiscal year this Service will be charged with the administration of the sum of $2,821,840.

The engineering work of the Department of Agriculture is thus separated and coördinated, and will come under the supervision of the Chief of the present Office of Public Roads, Logan W. Page. To this organization is added a division of drainage investigations, a division of irrigation investigations and scattered lines of work relating to farm buildings and machinery, farm waterworks, etc. Mr. Page states that the work of the new Office of Public Roads and Rural Engineering will be carried out on the plan of organization now pursued by the Office of Public Roads, so far as practicable. This is a plan of practically distinct divisions in charge of responsible heads.

The Commission Plan of Government for Hoboken, N. J., has been declared adopted after a recount of the popular vote of some weeks ago. The recount increased the majority of three votes to 13 votes. Hoboken had a population of 70,324 in 1910.

A Municipal Forest for St. Paul, Minn., is under consideration. Two years ago the Minnesota legislature passed a bill authorizing cities and villages in that State to establish and maintain municipal forests. A bill now before the legislature provides for the transfer by the state to the city of 22 acres of wooded land adjacent to a state fish hatchery.

Specifications For Power-Wire Crossings over railways and other utility lines are being revised by the National Joint Committee on Overhead and Underground Line Construction. The Committee asks advice as to desirable requirements, and detailed criticisms of any clause in the present standard specifications. R. D. Coombs, Consulting Engineer, 30 Church St., New York City, is Secretary.

New South Side Tunnel in Pittsburgh—A project for another tunnel through the hills on the South Side, Pittsburgh, is in an active stage. The county commissioners this week authorized A. D. Neeld, who prepared preliminary plans for a tunnel through Mount Washington connecting Carson St. and Warrington Ave., to proceed with the preparation of complete plans. Bids are likely to be called for in a few weeks.

The Standard Barrel for Dry Commodities, according to a recent act of Congress, has a length of stave of 28½ in., diameter of head 17⅛ in., distance between heads 26 in., circumference at bulge 64 in. outside measurement, and a thickness of stave not greater than ¼ in. It is provided that any barrel of a different form having a capacity of 7056 cu.in. shall be a standard barrel. The law will go into effect July 1, 1916.

A Rotary Kiln Plant to recover the waste lime from the caustic soda department of Jos. Bancroft & Sons Co., Wilmington, Del., is now being designed by Richard K. Meade, of Baltimore, Md. This will be the first rotary kiln installed for this purpose in the textile industry. The buildings will be of steel, and producer gas will be used as a fuel. The plant will contain a number of novel features in connection with the handling of the waste lime and its dewatering.

Southern Pacific Ry. Officials met in Portland, Ore., on Mar. 22 to discuss company affairs in Oregon. One of the important questions was the matter of extending the work of electrifying branch lines in the state. Present at the conference were Julius Kruttschnitt, New York, Chairman of the Board of Directors; William Sproule, San Francisco, President; W. R. Scott, Vice-President and General Manager; and William Hood, Chief Engineer. Following the conference a trip was taken over the Oregon lines already electrified.

A Water-Works Dam and Reservoir in Parley's Cañon is projected by Salt Lake City, Utah. Preliminary investigations to determine the depth of bedrock have been made and it is probable that plans will be prepared during the coming season. When the work is undertaken it will be done by contract. It is proposed to build the dam to a height of 50 ft. at first, and later on to carry it up to 100 ft., thus storing 250,000,000 and 1,000,000,000 gal. of water, respectively. Sylvester Q. Cannon is city engineer of Salt Lake City.

The Port of Para, Brazil, one of the leading harbor enterprises in South America, if not in the world, was put in the hands of a receiver on Mar. 25 by a judge of a United States District Court. The port, described in "Engineering News," Jan. 2, 1913, p. 30, was organized in 1906 to develop harbor facilities under a concession from the Brazilian government and was incorporated in the State of Maine. Failure to pay the interest on bonds led to the receivership. The corporation not only controls the extensive port works at Para, but has interests in steamship companies and in the ill-fated Madeira-Mamoré railway.

Flood-Prevention Work on Inland Rivers may possibly be undertaken by the Federal Government in coöperation with the localities affected. A clause in the river and harbor bill just enacted provides that the Chief of Engineers may have examinations and surveys made "with a view to devising plans for flood protection and determining the extent to which the United States should coöperate with the states and other communities in carrying out such plans, its share being based upon the value of the protection to navigation." The rivers named are the Cheat, Tygarts, Westport, Kanawha, Muskingum, Scioto, Miami, Maumee, Kankakee and Wabash.

No High-Pressure Fire Protection for Atlantic City Beach—An estimated cost of over $500,000 for the installation of a high-pressure salt-water fire main to protect structures on the beach front at Atlantic City, N. J., was declared to be an "insuperable objection" after a conference between the City Commission and J. H. Howland, an engineer of the National Board of Fire Underwriters. To give adequate protection, Mr. Howland believed that a high-pressure main should extend along the ocean front from Maryland to Michigan avenues, belting the greater part of the hotel district. The estimate for the real estate required was $2000 per acre for 200 acres and for a pumping station, $150,000.

The Status of the Provincial Power System of the Ontario Hydro-Electric Commission is disclosed in the annual report, recently made public. The total capital expenditure has mounted to $10,130,000, of which $5,961,000 is in the Niagara system. On this the total energy consumption is 50,752 hp., which cost the 63 municipalities taking it for redistribution $465,000. These municipalities had an investment in plant and equipment of $12,901,000 and liquid assets of $2,348,000. On this the annual fixed charges (interest and sinking fund) were $662,000. The aggregate surplus acquired by these cities (covering from one month to three years) now amounts to $1,601,000, not including reductions made in debenture debt.

The Engineers' and Architects' Controversy in Illinois over the restrictions imposed upon structural engineering by the present architects' license law has been discussed by the Board of Direction of the Western Society of Engineers, Chicago. The Board has passed resolutions to the effect that the present law is detrimental to the practice of engineering and to the public interests. It favors the following remedies: 1, the repeal of the law, or its amendment to permit equal privileges to engineers and architects; 2, the adoption of a state building code that will secure protection of the public without hardship to either engineers of architects; 3, if neither of these remedies can be effected the Board would favor the passage of a bill for the licensing of structural engineers.

A Master Track-Scale has been installed in St. Paul, Minn., in obedience to a recent law of Minnesota requiring the Railroad and Warehouse Commission to test railroad track-scales. This master scale is used by the railway companies as well as by the Commission for testing test cars. It was officially calibrated and sealed, after its completion by the Federal Bureau of Standards and was found to be sensitive to 2 lb. anywhere on the platform when the scale was under a load of 100,000 lb. The scale is constructed on the Fairbanks system and is 54 ft. long, is built in four sections and has an effective weighing rail 50 ft. long. The deck is of the rigid type supported by steel I-beams. In designing the scale a theoretical load of 150 tons plus 15 tons dead load was assumed as being evenly distributed over the lever system. This reduces to 4125 lb. per lin.in. on the main lever knife-edges.

Paving Work in St. Paul, Minn.—All paving work in St. Paul is now done by force account under the charge of the Commissioner of Public Works. During the year 1914 a very large area of creosoted-block paving was laid, probably the largest in one piece in the United States. This was the paving of University Ave., which is the main thoroughfare leading to the Midway District, the State University, and Minneapolis. The length paved was 4 mi. long, extending easterly from the boundary line of St. P l and Minneapolis. It was paved for a width of 69 ft. with the exception of ¼ mi. in the Midway manufacturing district, which was paved 95 ft. in width. The total creosoted-block area outside of the street-car tracks was 128,786 sq.yd., a 2-ft. strip outside of the rail, and between the rails the street-railway company laid 35,835 sq.yd. of granite-block pavement. A 3½-in. creosoted block was used on a 5-in. concrete base and the net cost of the pavement was $2.60 per sq.yd.

The Storm King Highway at the northern entrance to the Hudson Highlands, along the steep slope of Storm King Mountain, will have its construction delayed for some time. The bids for the construction of the road, which were received last year, have all been rejected by State Highway Commissioner Edwin Duffy on the ground that the cost of the road was likely to exceed the available appropriation. It is stated that the designs for the road will be restudied with a view to reducing the cost of construction. There is at present no highway whatever along the west shore of the Hudson River between Cornwall and West Point, and traffic has to make a long detour westward to the road on the western slope of Storm King and Crow's Nest Mountains. The proposed new highway will be one of the most spectacular pieces of road construction in the United States. Bids for the work may be again called for after the new designs have been completed.

The First Six Months of Commercial Operation of the Panama Canal were completed on Feb. 15, 1915. In that period 496 vessels, other than Canal equipment, passed through the

Canal carrying 2,367,244 tons of freight. Slightly over 41% of the cargo handled has been in movement between ports of the United States, in what is classified as United States coastwise trade. Over 21% of all the cargo has been in movement between the Pacific coast of North America, principally the United States, and Europe; and approximately 21% has been moving on the route between the west coast of South America and the seaports on the Atlantic seaboard of the United States and Europe. Traffic between the Atlantic seaboard and the Far East has amounted to over 12% of the whole. All together, the foregoing routes have been used for the transit of all but approximately 2½% of all cargo sent through the Canal. The six principal commodities shipped through the Canal have been, in order of their tonnage: Grain, nitrates, coal, refined petroleum products, lumber, and cotton. The six commodities together have amounted to approximately one-third of all goods shipped through.

The Joint Sewage-Disposal Works for Plainfield, North Plainfield and Dunellen, N. J., noted on p. 867 of our issue of Apr. 16, 1914, is going slowly forward. Some progress has been made on the construction of the outfall sewer, but practically nothing has yet been done on the disposal plant. The latter will include two-story settling tanks of the Imhoff type for both preliminary and final sedimentation. There have been delays over right-of-way acquirement, which it is hoped will soon end. A writ of certiorari against the installation of a sewage-treatment plant was applied for in May, 1914, but denied. Recently an application for an injunction against the installation of the plant has been filed by neighboring property owners. Sewage-collecting systems are being constructed by North Plainfield and Dunellen. Plainfield has had sewerage and sewage-disposal systems for a number of years past. Its present sewage-treatment works, which are located within the city limits in a district which is being occupied more and more by buildings, will be given up when the joint sewage-treatment plant is ready for use. George W. Fuller, Consulting Engineer, 170 Broadway, New York City, is engineer for all the work mentioned.

Plans for the Reclamation of 98,000 Acres of Land along the Big Black River, in Mississippi, have been prepared by the engineers of Drainage Investigations of the U. S. Department of Agriculture. These low lands are typical of large sections in some of the Southern States where there were formerly heavy growths of valuable timber. With the cutting of this timber, however, the land has become valueless unless drained and put under cultivation. The plan for the ultimate reclamation involves the excavation of a main ditch and laterals in the upper portion of the valley, and the construction of a leveed floodway throughout the remaining portion. Provision for tributary streams and for interior drainage is also made. To carry out this work, 36 drainage districts are planned. The total estimated cost, exclusive of clearing the main floodway, varies in different drainage districts from $15.72 to $44.36 per acre, the average cost for the entire 36 districts being $23.06. It is recommended that the clearing of the main floodway be done by a separate organization comprising all of the overflowed land below district No. 1, exclusive of that of the floodway itself. On this basis the cost of clearing would be $5.21 per acre benefited. It will be necessary to provide sedimentation areas at the lower extremities of the several tributaries of the river, and to take immediate steps to arrest the hillside erosion now taking place within the watershed. These bottom lands are narrow in proportion to the large amount of water to be provided for, and hence the cost of reclamation is high.

The Elwell Road Law has been repealed by the Minnesota legislature. The law was passed four years ago and provided that a county board on the petition of six or more land owners could establish and construct arterial roads and issue bonds of the county to finance the work, if it was approved by the state highway commission. For these roads the state paid one-half, the country one-fourth and the property benefited one-fourth. Payments were made in ten annual installments, the county paying the interest on the state's portion. During the four years that this law has been in force the northern part of the state has taken advantage of it to open up roads through undeveloped land, to the great advantage of that portion of the state; but it has also been taken advantage of in the well populated districts, in which the roads built under it would require partial reconstruction before full payment of the bonds. One of the strong points made for its repeal was that the law was badly drawn and led to extravagances in road building, and created a heavy lien on the property adjoining the improvement. On the day after the law was repealed the state supreme court upheld its constitutionality in a test case. J. W. Cooley, Chief Engineer of the Minnesota Highway Commission, is quoted by the Minneapolis "Tribune" of Mar. 20 as saying that the repeal of the Elwell law will entail an immense amount of extra work on the highway commission's engineers; that work formerly done by engineers employed by the counties must now be done by the commission's engineers, and that present appropriations would not begin to do all the work needed. The roads and highway bridges in Minnesota are under the jurisdiction of the state highway commission. They are provided for by a fund of $150,000 per annum for the administration of road affairs. The money is raised by a one mill state tax and amounted in 1914 to $1,400,000. The minimum allowance to any county is 1%. Of this fund 20% together with the due proportion of county funds is used solely for the maintenance of state roads.

The Dalles-Celilo Canal, built by the United States Government on the Columbia River to open navigation from the lower to the upper river, will be officially opened on Wednesday, May 5, at 2 p.m. The completion of this important work is to be celebrated by the citizens of Washington and Oregon in a series of festivities, beginning at Lewiston, Idaho, on Monday, May 3, and terminating at Portland, Ore., on Thursday, May 6. A fleet of river steamers will start from Lewiston after the celebration there and proceed down the Snake and Columbia Rivers, stopping to participate in celebrations at various river cities. The completion of this canal will for the first time make possible continuous navigation from the lower Columbia River to the upper Columbia and Snake Rivers in Washington, Oregon and Idaho. The other great obstruction to navigation on the Columbia, at the Cascades, was overcome by a canal which was completed by the Federal Government in 1896. The total expenditure upon this work was nearly $4,000,000, but it has remained practically unused for nearly a score of years awaiting the construction of some means of passing the falls and rapids between The Dalles and Celilo. A boat railway was originally planned by Capt. Edward Burr in 1894 to carry vessels past these obstructions, but in 1900 a canal and locks were substituted, and in 1905 Congress began appropriations for the work, the total cost of which is in the neighborhood of $5,000,000. The new canal has five locks 300x45 ft., with a depth of 7 ft. over the miter-sills. The canal prism has a width of 65 ft. at the bottom and is 8½ mi. in length. The completed Cascades Canal passes vessels of about the same draft. There would have been no object in giving a greater depth to these canals, since the Columbia and Snake Rivers above these canals have many rapids and shoals and are therefore navigable only by river steamers of moderate draft.

ENGINEERING SCHOOLS

RENSSELAER POLYTECHNIC INSTITUTE—A gift of $50,000 has been made by A. T. White, '65, of New York City, for beginning the construction of dormitories on the institute grounds. It is intended to use a unit system of design to allow for growth. The architecture will conform to that of the majority of the institute buildings.

UNIVERSITY OF PENNSYLVANIA—A course in town planning and municipal housing has been arranged for the Summer School. It is intended particularly for the benefit of housing inspectors, town-plan commissioners, etc. The course will start in July and will be given by Carol Aronovici, Director of the Bureau of Social Research; B. J. Newman, Secretary of the Philadelphia Housing Commission; B. A. Haldeman, Engineer in Charge of Philadelphia city-planning work, and Prof. J. P. Lichtenberger, of the University.

UNIVERSITY OF ILLINOIS—Methods and apparatus have been developed by the Department of Physics of the University of Illinois, whereby the reflection, absorption, and transmission of sound for different materials may be tested experimentally. A large basement room in the Physics Laboratory, with cemented walls, ceiling, and floor, serves as a resonance chamber for the absorption tests, while a specially constructed resonator and organ pipe are used to measure the reflection and the transmission. The work

has been developed by Dr. F. R. Watson, under whose direction the correction of the acoustic properties of the university auditorium was successfully carried out. This equipment is to be used in connection with a proposed course of instruction in architectural acoustics.

PERSONALS

Mr. G. L. Johnson, of Falls City, Neb., has been appointed State Engineer of Nebraska. His assistant will be William Steckelburg, of Lincoln, Neb.

Mr. J. H. Smith, M. Am. Soc. C. E., recently Assistant Engineer for the Oregon Short Line R.R., Nampa, Idaho, has been appointed State Engineer of Idaho.

Mr. L. B. Wickersham, Assistant Engineer of the Spokane, Portland & Seattle Ry., with headquarters at Portland, Ore., has resigned to engage in the general practice of engineering.

Mr. S. Percy Hooker, former Chairman of the New York State Highway Commission, and for several years Chairman of the New Hampshire State Highway Commission, is seriously ill at the New York Hospital, New York City.

Gen. Grenville M. Dodge, Chief Engineer of the Union Pacific R.R. at the time it was built across the Western plains and a prominent Civil War veteran, has been elected an honorary member of the American Society of Civil Engineers.

Mr. George W. Fuller, M. Am. Soc. C. E., Consulting Hydraulic Engineer and Sanitary Expert, New York City, has been elected a member of the Institution of Civil Engineers of Great Britain and also of the Verein Deutscher Ingenieure.

Mr. A. P. Robertson, Assoc. M. Am. Soc. C. E., recently Vice-President, and Chief Engineer of the W. E. Austin Machinery Co., Atlanta, Ga., has become associated with the Insley Manufacturing Co., engineers and manufacturers, Indianapolis, Ind., as Manager of Sales.

Mr. J. G. De Remer, M. Am. Soc. M. E., formerly Chief Mechanical and Electrical Engineer of the United Light & Power Co., San Francisco, has been appointed Manager of the General Engineering Department of the American District Steam Co., of North Tonawanda, N. Y.

Mr. Lewis Nixon, Consulting Engineer of the Borough of Richmond, New York City, and recently Acting Commissioner of Public Works, has resigned to engage in private business. Mr. Nixon is a former naval architect and shipbuilder, and it is reported he will return to this work.

Mr. Henry C. Morrison, former General Sales Manager of the McCormick Waterproof Portland Cement Co., is now connected with the Sandusky Portland Cement Co., as Western Representative and Waterproofing Engineer, with offices at 710 Railway Exchange Bldg., St. Louis, Mo.

Mr. Alexander Robertson, recently Assistant to the President of the Missouri Pacific Ry., has been elected Vice-President of the Missouri Pacific-Iron Mountain Ry. system in charge of operation. Mr. Robertson was formerly Vice-President and General Manager, and from 1911 to 1913, President of the Western Maryland Ry.

Mr. E. J. Pearson, M. Am. Soc. C. E., First Vice-President of the Missouri Pacific Ry., has been elected Vice-President of the Texas & Pacific Ry., with headquarters at New Orleans, La., succeeding Mr. E. F. Kearney. Mr. Pearson will be in charge of operation and will also have charge of the construction of the new terminals at New Orleans.

Mr. Milton H. Bronsdon has been elected Deputy Commissioner of Public Works and City Engineer of Providence, R. I., succeeding Mr. Otis F. Clapp, M. Am. Soc. C. E., City Engineer, as noted elsewhere in these columns. Mr. Bronsdon was for about five years Chief Engineer of the Rhode Island Co., which controls practically all of the street-railway lines of Providence and vicinity.

Mr. Otis F. Clapp, M. Am. Soc. C. E., until recently City Engineer of Providence, R. I., has been made First Assistant Engineer of the Department of Public Works, with a salary of $3900 per annum. Mr. Clapp was elected City Engineer of Providence in 1897 and held the office continuously until a recent legislative act created the office of Deputy Commissioner of Public Works, making this official also City Engineer.

Mr. J. S. Garland, an engineer of the Washington, D. C., Water Department since 1893, has been appointed to succeed the late Walter A. McFarland, M. Am. Soc. C. E., Superintendent of the Department. Mr. Garland was born in Washington in 1859 and was educated in the public schools of that city and at the Maryland Agricultural College. He entered the Water Department of the District of Columbia in 1893 as Assistant Engineer.

Mr. George A. Ricker, M. Am. Soc. C. E., fomerly First Deputy Highway Commissioner of New York State, and recently Consulting Engineer of the New York State Department of Highways, has resigned and is now engaged in private practice, with offices at 188 State St., Albany, N. Y. Mr. Ricker has had 30 years' experience in steam- and electric-railway location and construction, in foundations, concrete structures, bridges, buildings and the general practice of engineering.

Mr. B. H. Bryant, M. Am. Soc. C. E., has returned from Guatemala, Salvador and Honduras, where he had been Chief Locating Engineer of the International Ry. of America, and is taking a vacation in Washington, D. C. Mr. Bryant has acted in the capacity of Division Engineer, Chief Engineer, Construction Engineer and General Superintendent of steam railroads in the United States, Canada, Mexico, Brazil and South American countries for many years. He expects to return to active work in the near future.

Mr. Geo. Rockwell Putnam, Commissioner in Charge of the U. S. Lighthouse Service, whose paper on the recent engineering work under his charge is published elsewhere in this issue, is a native of Davenport, Iowa. He graduated from Rose Polytechnic Institute at Terre Haute, Ind., in 1890, and received an appointment on the U. S. Coast & Geodetic Survey. He was at various times engaged on the surveys of the international boundary between the United States and Mexico, and between Alaska and the Dominion of Canada, and in 1896 went as astronomer on an expedition to Greenland. From 1900 to 1906 he was Director of the Coast Surveys of the Philippine Islands. He was appointed Commissioner of the Lighthouse Service by President Taft in 1910.

OBITUARY

Daniel C. O'Keefe, a retired contractor, died at his home in Kansas City, Mo., Mar. 21, at 80 years of age. He went to Atchison, Kan., in 1857 and was engaged in the contracting business there until 1890, when he moved to Kansas City. He was a native of Ireland and came to America in 1850.

W. B. McLoughlin, Engineer of Maintenance-of-Way of the Cleveland, Cincinnati, Chicago & St. Louis R.R., with headquarters at Indianapolis, Ind., died Mar. 15, at St. Mary's Hospital, Cincinnati, Ohio, as the result of injuries received in a motor-car accident near Lawrenceburg Junction, Ind., on Mar. 12.

John C. Breedlove, Assistant Engineer of the Northern Pacific Ry. at Tacoma, Wash., died Mar. 10 at his home in that city. He graduated from Cornell University in 1901, and for several years was Assistant Engineer of the Chicago, Rock Island & Pacific Ry. For the past four years he has been in charge of work on the Northern Pacific Ry. on the new low-grade line between Tacoma and Tenino, Wash.

J. A. Gaboury, a contractor and promoter of Jacksonville, Ala., died in Baltimore on Mar. 23. While he was president of the mule street-car line in Montgomery, Ala., he became acquainted with C. J. Van de Poele, one of the early electric-railway experimenters, and financed the line started in Montgomery in 1886. He claimed to be the inventor of the trolley-pole, which supplanted the trolley carriage and cable used at first. He was 63 years old and a native of Canada. A son survives him.

Hiram E. Perry, M. Am. Soc. C. E., died Mar. 8 at his home in Flint, Mich., as the result of injuries received in a runaway accident three weeks previously. Mr. Perry was a graduate of the University of Michigan, class of 1878. After teaching school for several years he engaged in railway construction in Texas and Michigan, and for thirteen years was City Engineer of Saginaw. Later, he was City Engineer of Flint for several years, resigning two years ago to engage in private practice. He was 60 years old, and leaves three daughters and one son.—Contributed by A. J. Wenzell, M. Am. Soc. C. E., Ann Arbor, Mich.

J. Foster Crowell, M. Am. Soc. C. E., Consulting Engineer of the Borough of Queens and Street Cleaning Commissioner of New York City under Mayor McClellan, died at his home in Flushing, L. I., Mar. 29, in his 67th year. He was born in West Chester, Penn., and was graduated from the Polytechnic College of Pennsylvania in 1867, after which he became attached to the city engineering staff of Philadelphia. He was Principal Assistant Engineer in laying out the

grounds and buildings for the Centennial Exposition in 1876. Subsequently, he was appointed Consulting Engineer of the Republic of Haiti and of the City of New York, and was also retained by several other Eastern cities in the same capacity. Mr. Crowell took an active part in planning the water-supply of New York and in introducing the supplementary water-supply for fire protection now in use in the lower part of the city. During the Civil War he joined the Home Guard and was on active duty at the time of the draft riots. He was a member of many technical and scientific societies and was the author of several books on engineering. Mr. Crowell left a widow and two sons.

At the funeral in Philadelphia of the late Frederick Winslow Taylor, whose death was announced in our last issue, tributes to Mr. Taylor were offered by James Mapes Dodge and Norris L. Cooke. The following is quoted from Mr. Cooke's remarks:

So much stress has been put upon the practical accomplishments of Frederick W. Taylor that the great reach and sweep of his spirit has—except for the few—been almost submerged. All this lifetime of patient, tireless investigation; all the acuteness of his highly scientific mind; all the aspirations of a sensitive nature were bent on the one end—of making human life a better thing to live. To this object he made the freest possible sacrifice of his fortune, his time and his health.

He tinged all our work with ideality. Hear his own words: "I can no longer afford to work for money." "All our inventions and changes are made to produce human happiness." "In all your relations do to the other fellow what you would have him do to you."

Standing beside the body of our fallen leader, I wish I could convey even the slightest suggestion of what his inspiration has been to his followers and what a calamity has come to them, as to the world, in his death. I wish that to you, and through you who are here, I could issue a call that would seal the solidarity of this movement for the bettering of human relations in business and industry, for which Mr. Taylor gave his life.

If we could only lose ourselves as he lost himself in his love of humanity. If we could only have the supreme confidence in the final outcome which he never lost. If we could only care as little as he cared about being numbered with the crowd, when the crowd was wrong.

Clean cut in his vision and keen in his judgments, fearless of criticism or misunderstanding, Frederick W. Taylor rang true in every act. He thought straight and spoke his mind with no uncertain sound, and his speaking cleared the air of sophistries and evasions. No man who was ever honored by his friendship, sustained by his counsel, upheld by his invincible spirit, can ever willingly set himself an easy task or be unwilling to tread the difficult way, so it be straight and clear.

Sir Charles A. Hartley, whose death was noted in the obituary columns of Mar. 18, was a member of the Advisory Board appointed by James B. Eads, to assist him upon the improvements which were proposed and carried out at the mouth of the South Pass of the Mississippi River. The Board first met September, 1875. It consisted of General Barnard, Colonel Milnor Roberts, T. E. Sickles, Prof. Henry Mitchell, U. S. Coast Survey, and H. D. Whitcomb. The most important work of Sir Charles was as Chief Engineer and Chairman of the European Commission of the Danube. He held this position from 1856 to the time of his death, 59 years, although during recent years in a consulting capacity. He wrote two important papers on the subject of this improvement for the Institution of Civil Engineering, one in 1862 and the other in 1873. The work was authorized in 1856 by virtue of the Treaty of Paris. The Commission of delegates from the seven contracting powers are: Austria, England, France, Prussia, Russia, Sardinia and Turkey. The original works were commenced in 1858 and completed in 1861. In 1866 the Commission decided to convert the piers (jetties) into solid structures, which work was finished in 1871. In 1874 Sir Charles, in a letter of considerable length, compared the mouth of the Danube with that of the Mississippi and predicted the success of the proposed jetties at the latter place. (See pages 52-59 and page 92 of "The Mississippi Jetties" by Corthell.) The obituary notice in "Engineering News," Mar. 18, does not mention the Danube jetties. They were of very great importance not only for the immense commerce of the several countries using the mouth of that great river, but as a very successful example of jetties at the mouth of a great sediment-bearing river, and their success exerted an important influence upon the minds of the United States Government Board which went to Europe in 1874 to examine these and other jetty works for the purpose of deciding upon the feasibility of a similar treatment at the mouth of the Mississippi River. The sound advice given by Sir Charles, and his great ability and long experience led to his engagement by Mr. Eads as one of his Consulting Engineers. (Not by the President of the United States as the previous obituary gives it.) He visited the United States and the mouth of the Mississippi River in 1875 and his counsels, as one of the Advisory Board, were of great advantage to the enterprise then and throughout the entire work.—Contributed by Elmer L. Corthell.

ENGINEERING SOCIETIES

COMING MEETINGS

MONTANA SOCIETY OF ENGINEERS.
Apr. 8-10. Annual meeting in Butte. Secy., Clinton H. Moore, Butte, Mont.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION.
Apr. 22-23. Annual convention at Keokuk, Iowa. Secy., H. E. Weeks, Davenport, Iowa.

AIR BRAKE ASSOCIATION.
May 4-7. Convention at Chicago. Secy., F. M. Nelis, 53 State St., Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.
May 10-14. Annual meeting in Cincinnati. Secy., J. M. Diven, 47 State St., Troy, N. Y.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 11-13. Annual meeting at Hotel Astor, New York City. Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass.

CONFERENCE OF BUILDING INSPECTORS.
May 14. Meeting in New York City. Secy., Sidney J. Williams, Madison, Wis.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 17-20. Annual meeting at Chicago. Secy., C. G. Hall, 922 McCormick Bldg., Chicago.

American Society of Civil Engineers—The annual convention will be held in San Francisco, Calif., Sept. 16-18, 1915, these dates being the Thursday, Friday and Saturday immediately preceding the International Engineering Congress, which lasts for a week.

Tri-State Good Roads Association—Plans are being made for a Good Roads Congress to be held in San Francisco during the week beginning Aug. 2. The congress will be conducted under the auspices of the Tri-State Good Roads Association in the interests of the States of California, Oregon and Washington.

Air Brake Association—At the 22d annual convention of the Air Brake Association, to be held at the Hotel Sherman, Chicago, Ill., on Tuesday, May 4, the following subjects will be discussed: "Adequate Hand Brakes on Heavy Passenger Equipment Cars"; "What Shall We Do to Improve the Present Pneumatic Signal Device"; "M. C. B. Air-Brake Hose Specification."

Engineers' Society of Pennsylvania—The 11th Anniversary of the forming of the Society was celebrated with a banquet at the Harrisburg Club, Harrisburg, Penn., on Mar. 27. Those present numbered 160. The addresses dwelt for the most part upon the relation of the engineer to modern industrial economics and political conditions. Farley Gannett, President of the Society, opened the banquet with a short historical address.

The International Congress of Navigation—This Congress, which was to have been held at Stockholm, Sweden, in August, 1915, has been indefinitely postponed. Reports from the executive bureau of the association at Brussels state that since Sept. 7 last the central office of the association at Brussels has been occupied for military purposes so as to prevent all work of the bureau, including even the distribution of documents already printed and ready for issue. The work of the bureau will be resumed as soon as conditions permit the reopening of the office.

Canadian and International Good Roads Association—The second annual convention was held at the University of Toronto, Mar. 22-26, and was attended by several hundred delegates from Canada and the United States. In the absence of W. A. McLean, President of the association, the chair was occupied by W. H. Dandurand, of Montreal, Honorary President of the Canadian Good Roads Association. The program included papers on all phases of road construction, maintenance and economics, and the speakers included R. A. Meeker, State Highway Engineer of New Jersey; W. W. Crosby, Consulting Engineer, of Baltimore, Md.; W. H. Sohier, Chairman of the Massachusetts State Highway Commission, and many others. The convention included an exhibition of road-building material and model road-building machinery. The Canadian Good Roads Association elected the following officers: Honorary Presidents, W. A. McLean, Toronto, and W. H. Dandurand, Montreal; President, B. Michaud, Deputy Minister of Roads for Quebec Province; Secretary and Treasurer, G. A. McNamae, Montreal. The following officers were elected for the Ontario Good Roads Association: Honorary Presidents, N. Vermilyea, Belleville, and J. A. Sanderson, Oxford Station; President, S. S. Squire, Waterford; Vice-Presidents, K. W. McKay, St. Thomas, and C. R. Wheelock, Orangeville; Secretary and Treasurer, George S. Henry, Todmorden.

Appliances and Materials

Safety Crane Hook

The safety hook shown in the accompanying sketch has recently been invented by Ralph Clarke of the Contractors Trading Co., New York City, and is being made by the Dobbie Foundry & Machine Co., Niagara Falls, N. Y., the scheme is simple and in practice has been found very effective. The hoist chain, or sling or bail or whatever may be in the hook,

CLARKE SAFETY HOOK

is locked in, and the handle must be drawn back before the load can be detached. The hooks are made with shackles in capacities of 3 to 10 tons ($10 to $21) and for sheave blocks in capacities of 3 to 20 tons ($5 to $25).

* * *

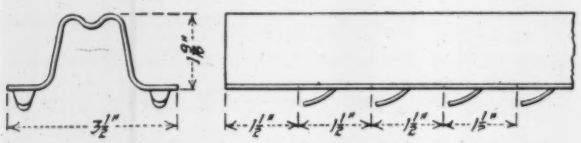
Small High-Pressure Triplex Pump

To meet a demand for a small and inexpensive high-pressure hydraulic pump to supply presses, etc., the Hydraulic Press Manufacturing Co., of Mount Gilead, Ohio, has added a new type to its line. This has three single-acting plungers of ⅞- to 1-in. diameter (for pressures of 8000 to 750 lb. per sq.in., respectively) and 2¾-in. stroke. At 150 r.p.m. the capacity ranges from 0.41 to 4.20 gal. per min. according to size of plunger. The frame is a single casting. The crank shaft is machined from a steel bar; crossheads are cold-rolled steel. Connecting rods are of malleable iron and have bronze bearings. Plungers are of steel for the highest pressures and bronze for the lower. All three cylinders are in a single block, of steel or bronze. The pump is 16x18 in. on its base and is 35 in. high over all; the weight is 500 lb.

* * *

Unique Steel Fence Posts

The novel design of fence post shown in the accompanying sketch has recently been developed by the Metal Post & Culvert Co., Niles, Ohio. The line posts are of steel plate, pressed into a shape best calculated to withstand bending. There is a multitude of small outstanding tongues to grip the wire fencing. A malleable-iron cap is used for ordinary



STEEL FENCE POST WITH WIRE GRIP

driving; in stony ground a small auger hole is sunk first. Great convenience in storage and shipping is claimed. Posts are made in lengths of 5 to 12 ft. (7 to 17 lb.). Special braced and anchored end and corner posts are used.

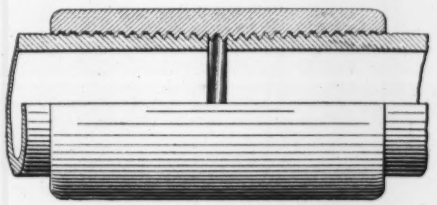
* * *

Hanna Irrigation Flow Meter

An inexpensive meter for registering the flow of water in rated canals and over standard weirs has been designed by F. W. Hanna of the U. S. Reclamation Service and is being made by the Hess Flume Co. of Denver. A counterweighted float rests in a stilling box and its tape runs over a pulley in the meter. The pulley shaft carries a cam whose outline is fixed by the rating curve of the canal or weir employed. This cam so moves a pivoted frame carrying a cylinder on a shaft that the cylinder changes its point of contact on a spherical disk, supported independently of the pivoted frame, according to the height of water (and consequently according to the flow). The disk is revolved by a clock and it drives the cylinder at a speed varying with the point of contact. The revolutions of the cylinder are recorded, as acre-feet, etc., by a mechanical counter.

Vanishing-Thread Pipe Joint

Marketing of the vanishing-thread joint shown in the accompanying sketch has been announced by the Reading Iron Co., Reading, Penn. It is intended to increase the strength of joints in signal pipe (for mechanically worked semaphores and switches). The vanishing thread has the same pitch and taper as the regular pipe thread; instead of ending abruptly with a few imperfect threads, the bottom of the thread continues at the same taper as the outside of the thread until it disappears at the outer surface of the pipe. At the last thread of the coupling the area of metal left in the cross-section of



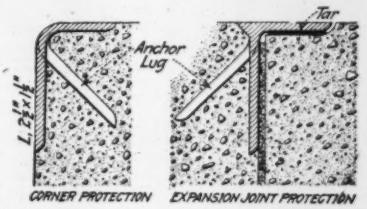
VANISHING-THREAD JOINT

pipe is very nearly the same as that of the unthreaded part. The thread can be reproduced in the field like the ordinary. In comparative tests of this and old-style plug-and-rivet joints, several lengths were given a long series of 10-in. strokes ending in blows. After 120,000 blows (600 ft.-lb.) some of the rivets in the old-style joints broke and after 180,000 all were gone. The new joints were given 1,125,000 blows (1000 ft.-lb.) without failure and tests were dropped.

* * *

Protection Bar for Concrete Curbs and Joints

A new self-anchoring bar for protecting the corners of concrete curbing and the edges of concrete paving at expansion joints is made from a steel angle 2½x1½ in., about 2½ lb. per ft. Anchor lugs, about 6 in. apart, are sheared out of the vertical leg and bent so as to be embedded in the concrete. For the protection of joints in concrete paving, floors, walls, bridge decks, etc., a bar is used, with its vertical leg in the face of one section of the concrete, while



STEEL PROTECTING BAR FOR CORNERS AND JOINTS OF CONCRETE WORK

its horizontal leg laps over the adjacent section. In this way the joint itself is relieved from direct wear. A special form of joint bar with heavy horizontal leg is shown. These bars are being put on the market by the Universal Concrete Bar Co., 167 W. Washington St., Chicago.

* * *

Special Time-Study Stop Watch

A new stop watch for observations of manual and machine movements, etc., has its dial so graduated as to show not only the time for the observed movement or operation, but also the equivalent number of such movements per hour or per day. It thus eliminates much of the computation commonly involved in work of this kind. The dial is graduated to tenths and hundredths of minutes.

This device is the invention of L. I. Yeomans, industrial engineer, and the exclusive selling rights are held by M. J. Silverberg, People's Gas Building, Chicago.

* * *

Another American Diesel Engine

The Leonard B. Harris design of valveless Diesel engine will be made in this country by the Southwark Foundry & Machine Co., of Philadelphia. The proposed line runs from 75 to 1000 b.hp. in capacity. The inventor will be associated with this company as consulting engineer.